Anthropogenic Impacts on Forest Mammals in the Southern Mistbelt Forests in the Midlands of KwaZulu-Natal, South Africa

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ABSTRACT

Habitat loss worldwide is a major threat to biodiversity. Forest loss is affected by numerous factors, including natural climate change and anthropogenic disturbances (e.g., logging, habitat conversion or increased fire activity). Forest fragmentation results in reduced patch sizes, increased edge effects, and connectivity between patches negatively impacted. Forest fragmentation effects on species differ, with some considerably more sensitive to these changes than others, often resulting in their local extinction. By monitoring biodiversity, effective conservation measures can be implemented to conserve the biodiversity in these forests. Remote camera traps have become an increasingly popular tool to study wildlife in a reliable, non-invasive way.

Firstly, the use of camera traps as a research tool in Africa using a systematic review was determined. This highlighted the countries with studies that used camera traps the most, as well as determined the terrestrial wildlife and habitat types receiving the most focus. The findings from assessing camera trap research in Africa revealed that most studies were conducted in South Africa, with most studies focusing on the occupancy of mammals, with a particular focus being on large carnivores, the majority of which were leopard *Panthera pardus*. Most studies were conducted in forests, followed by savannah/bushveld.

Secondly, the presence of forest mammalian species was assessed in the Southern Mistbelt forests in the Midlands of KwaZulu-Natal, South Africa. These forests are fragmented because of both natural and anthropogenic factors. An extensive camera trapping survey was conducted between October 2020 and April 2021 (wet season), and between May 2021 and September 2021 (dry season), with 14 indigenous forest patches being sampled. A total of 339 camera trap stations were deployed in this study, with microhabitat conditions, in a 20 m radius around each camera trap, collected to determine their impact on bushbuck *Tragelaphus scriptus*, a diurnal forest specialist, and Cape porcupine *Hystrix africaeaustralis*, a nocturnal generalist, and how the microhabitat conditions potentially impacted their occupancy between the austral wet and dry seasons. Bushbuck were the most recorded mammalian species recorded during both seasons. Cape porcupine presence was recorded more during the dry season, with various microhabitat variables influencing their occupancy. Cape porcupines, as generalists, likely use the forest food resources during the dry season. Bushbuck presence was lower in state-owned forests, likely because of the hunting activities observed in these forests.

Thirdly, data collected from the camera trapping surveys were used to determine the influence of landscape factors, including patch size, landscape configuration (number of neighbouring patches), and patch isolation (distance from mainland patch), on forest mammalian species diversity in forest patches, between the wet and dry seasons. Patch size strongly influenced forest mammalian species richness, which was relatively low, with more species occupying larger patches than smaller patches. Similarly, landscape configuration affected species richness and was generally higher in those forests surrounded by multiple forest patches. Forest isolation, however, did not seem to be particularly impactful in determining forest mammalian species diversity.

Overall, this research showed the value of camera traps as a research tool and their effectiveness in studying rare and elusive mammalian species in Africa. Effects of anthropogenic disturbances on various forest mammalian species were highlighted, with activities such as hunting and uncontrolled resource harvesting, such as collection of fuelwood, medicinal plants and building materials by the local communities, impacting the presence of various forest mammalian species, particularly forest specialist species, such as the blue duiker *Philantomba monticola*. The importance of maintaining small forest patches, often considered of low conservation value, was highlighted. These act as essential ‘stepping stones’ between forest patches, allowing species to traverse a landscape mosaic. The need for conservation measures not to disregard the importance of these small forest patches is emphasised, as they are vital assets to maintain species richness in landscape mosaics with forest patches.

PREFACE

The data described in this thesis were collected in the Southern Mistbelt Forests in the Midlands of KwaZulu-Natal, Republic of South Africa, from October 2020 – September 2021. Field work, analyses and thesis writing was carried out while registered at the School of Life Sciences, University of KwaZulu-Natal, Pietermaritzburg, under the supervision of Prof Colleen T. Downs and co-supervision of Dr David A. Ehlers Smith and Dr Yvette C. Ehlers Smith.

This thesis, submitted for the degree of Doctorate of Philosophy in Science in the College of Agriculture, Engineering and Science, University of KwaZulu-Natal, School of Life Sciences, Pietermaritzburg campus, represents original work by the author and has not otherwise been submitted in any form for any degree or diploma to any University. Where use has been made of the work of others, it is duly acknowledged in the text.

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Craig P. Cordier

July 2023

I certify that the above statement is correct, and as the candidate's supervisor, I have approved this thesis for submission.

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Prof Colleen T. Downs (Supervisor)

July 2023

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DECLARATION 1 – PLAGIARISM

I, Craig P. Cordier, declare that the research reported in this thesis, except where otherwise indicated, is my original research. This thesis has not been submitted for any degree or examination at any other university. This thesis does not contain other persons’ data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons. This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then: Their words have been re-written but the general information attributed to them has been referenced. Where their exact words have been used, then their writing has been placed in italics and inside quotation marks, and referenced. This thesis does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source is detailed in the thesis and in the Reference sections.

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DECLARATION 2 – PUBLICATIONS

DETAILS OF CONTRIBUTION TO PUBLICATIONS that form part and/or include research presented in this thesis.

PUBLICATION 1: Global Ecology and Conservation (published)

Camera trap research in Africa: A systematic review to show trends in wildlife monitoring and its value as a research tool

Craig P. Cordier, David A. Ehlers Smith, Yvette C. Ehlers Smith and Colleen T. Downs

Author contributions:

CPC, DAES and YCES conceived paper with CTD. CTD sourced funding. CPC collected the data. CPC analysed the data and wrote the paper. CTD, DAES and YCES contributed valuable comments to the manuscript.

PUBLICATION 2: Formatted for Journal of Ecology- not submitted

Influence of historical pressures on the vegetation characteristics between the wet and dry season and their impacts on the occupancy of bushbuck and Cape porcupine within the Southern Mistbelt Forests of KwaZulu-Natal, South Africa

Craig P. Cordier, Nasiphi Bitani, David A. Ehlers Smith, Yvette C. Ehlers Smith and Colleen T. Downs

Author contributions:

CPC, NB, DAES and YCES conceived paper with CTD. CTD sourced funding. CPC and NB collected the data. CPC analysed the data and wrote the paper. CTD, DAES and YCES contributed valuable comments to the manuscript.

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Effect of seasonality and landscape factors on the occupancy of mammalian species within the Southern Mistbelt Forests of KwaZulu-Natal, South Africa

Craig P. Cordier, Nasiphi Bitani, David A. Ehlers Smith, Yvette C. Ehlers Smith and Colleen T. Downs

Author contributions:

CPC, NB, DAES and YCES conceived paper with CTD. CTD sourced funding. CPC and NB collected the data. CPC analysed the data and wrote the paper. CTD, DAES and YCES contributed valuable comments to the manuscript.

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A selection of camera trap images of some of the mammalian species in the present study

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CHAPTER 1

INTRODUCTION

1.1 The forest biome

Across the world, terrestrial vegetation could be categorised into nine biomes, which include: tropical rain forests, tropical dry forests (including savannas), temperate broadleaf forests, coniferous forests, Mediterranean-type (including fynbos and renosterveld), temperate grasslands, arid lands, tundra, and alpine (Prach and Walker 2020). The forest biome is estimated to cover a total area of approximately 4 billion ha, equating to ~20 % of the Earth's total land area (Kelatwang and Garzuglia 2006; Ellis and Ramankutty 2008), which is found in Europe (25%), followed by South America (21%), North and Central America (18%), Africa (16%), Asia (14%) and Oceania (5%) (Kelatwang and Garzuglia 2006).

These forests are a vital part of the world's ecosystem, providing critical environmental services, such as soil protection, species diversities, and maintaining the hydrological cycle (Kelatwang and Garzuglia 2006; Mithal et al. 2011). These forests also provide essential resources for millions of people across the globe (Mithal et al. 2011). In Africa, forest area is estimated to cover ~635 million ha, covering ~21% of Africa's land area (Kelatwang and Garzuglia 2006), but these forests have contracted in recent years (Bodart et al. 2013). Most of this forest cover is found along the equatorial zone, comprising a 4800 km wide expanse of natural forest, stretching from Sierra Leone to the East African great lakes (Aubréville 2013). Forests in Africa can be classified into four main categories, which include: dry tropical forests (found predominantly in eastern and southern Africa), humid tropical forests (western and central Africa), montane forests (particularly in eastern and southern Africa), sub-tropical forests (Kelatwang and Garzuglia 2006). Of these forests in Africa, 55% are classified as closed forests (>40% canopy cover) and are found predominantly in central Africa, with open forests

(15% - 40% canopy cover) comprising 45% (Kelatwang and Garzuglia 2006; Bullock et al. 2021).

Indigenous forests in southern Africa are evergreen, with forests in South Africa being the smallest biome, occupying ~0.6% of the total land surface area, which could be found in patches along the eastern and southern areas of the country (Mucina et al. 2006; Lawes et al. 2007; Adie et al. 2013; Grieve and Downs 2015; Mangwale et al. 2017). These forests generally occur in naturally fragmented, relatively small patches, with most being less than 100 ha in size (Mucina et al. 2006). These forests are scattered in those regions with appropriate rainfall, which needs to be an average of at least 525 mm annually (Mucina et al. 2006). The three main forest types in South Africa include the Indian Ocean Coastal Belt Forest, the Afromontane Forests, found inland, and Scarp Forests, which generally are found running perpendicular between the Afrotemperate and Coastal Forests, along river gorges (Lawes et al. 2007; Moir et al. 2020; Mulvaney et al. 2022).

The Afromontane forests, or Southern Mistbelt Forests, are the oldest forest type in South Africa, being formed ~18,000 yr B.P., before the last glacial maximum (LGM) (Lawes et al. 2007). They are naturally small and fragmented, found in a natural grassland matrix, with their overall distribution and size being fairly constant for the past 20,000 years (Lawes et al. 2000a; Lawes et al. 2005; Adie et al. 2013). These forests are mostly found between an altitude of 1000 – 1400 m a.s.l., with these forests exhibiting significant seasonal variations in rainfall, as well as a rough topography (Lawes et al. 2000a; 2005; Mucina et al. 2006). The environmental conditions faced by these forests, coupled with the severe climate and vegetation changes experienced by the forest fauna 100,000 years before and during the LGM, have resulted in these forest communities being resilient to the disturbances presently faced by these forests (Lawes et al. 2000a; 2005). The trees found in these forests are generally relatively tall (15 – 20 m) and exhibit a multi-layered structure (Lawes et al. 2005; Mucina et al. 2006). There are several emergent tree species which dominate these forests, particularly: *Podocarpus henkelii, Podocarpus latifolius, Afrocarpus falcatus, Xymalos monospora, Celtis africana, Calodendrum capense, Vepris lanceolata, Zanthoxylum davyi* and *Kiggelaria africana* (Lawes et al. 2005; Mucina et al. 2006).

1.2 Threats to natural forests

Although forests play a vital role in supporting life on earth by providing resources to the world's population, maintaining diversities, regulating climate, storing carbon, and protecting water and soil, forest loss over the past few decades has remained high across the globe (Heino et al. 2015; Moomaw et al. 2020). Many factors cause forest loss, from wildfires to direct human impacts, such as forest clearing, selective logging, wood extraction, population growth and associated land use change, forestry and shifting agricultures (Heino et al. 2015; Curtis et al. 2018). These factors have resulted in the considerable degradation of natural forest environments worldwide, with human activities driven by social, economic and demographic pressures being the most significant causes of forest loss (Curtis et al. 2018; Bodo et al. 2021). Due to this, global forest destruction has increased significantly over recent decades, with deforestation rates remaining high, with only half of the world's forests considered undamaged (Farwig et al. 2008; Meyfroidt and Lambin 2011; Ritchie and Roser 2021). The increasing human populations, coupled with the constant rise in demand for forest resources, have increased the area of degraded forests across the globe (Farwig et al. 2008; Bodo et al. 2021). Due to the loss of habitat and resulting fragmentation, habitat availability for biodiversity is reduced, leading to resource shortages and making wildlife more accessible to hunters (Lampila et al. 2005; Almeida-Gomes and Rocha 2014; Minhós et al. 2023). The improved understanding of the importance of forests has resulted in a global rise in protected areas over the last few decades, with large intact forests being of particular focus because of their vital role in maintaining ecological diversity (Heino et al. 2015).

Forest loss is highest in the tropics, which are experiencing human population growth pressures, whereby almost 1% of these natural forests are cleared annually, primarily by anthropogenic activities, such as the cultivation of land (Farwig et al. 2008; Hansen et al. 2013; Minhós et al. 2023). This is particularly evident where native populations clear forests for their crops (Aubréville 2013). Often trees are felled, with those remaining being burnt (Aubréville 2013). This practice results in gaps opening on the forest edge, often introducing wind and drought stress, as well as allowing fires to penetrate deeper into the forest (Alencar et al. 2006; Aubréville 2013; Fischer et al. 2021). The destruction and degradation of these natural forests, coupled with overhunting, are seen to heavily impact biodiversity, with many species being particularly vulnerable to these habitat transformations, especially those specialised species which rely on the resources found in natural forests (Farwig et al. 2008; Stork et al. 2009; Minhós et al. 2023). This is concerning as tropical forests are home to more than 60 % of the world’s biodiversity, although it only covers 7 % of the total surface area (Giam 2017; Minhós et al. 2023).

Deforestation is particularly serious in Africa, where annual forest loss was the highest, compared with the rest of the world, during the 1990s, with logging and conversion of forests to small and large-scale agriculture being the primary causes for deforestation (Kelatwang and Garzuglia 2006; Mithal et al. 2011; Aubréville 2013). The effects of deforestation are especially impactful in Africa, which experienced significant forest losses over the past few decades, where the loss of forest affects climate, water reserves and soil conservation more than other areas of the world (Kelatwang and Garzuglia 2006; Aubréville 2013; Ajanaku and Collins 2021). Between 2000 and 2005, forest loss in Africa was estimated to be around 4 million ha per annum, less than the forest loss observed in the 1990s, estimated to be around 4.4 million ha per annum (Kelatwang and Garzuglia 2006).

Like the rest of the world, forest loss in Africa is primarily caused by the conversion of forested areas to small-scale agriculture, with larger-scale conversions and other agricultural practices further contributing significantly to these forest losses (Kelatwang and Garzuglia 2006; Norris et al. 2010). Primary forests in Africa are the source of resources for many indigenous cultures, which rely on these forest ecosystems to provide fuelwood and income-generating products (Kelatwang and Garzuglia 2006; Kormos et al. 2017). Presently, these forests are under threat mainly from the pressure of logging and hunting, with hunting being responsible for the removal of many wildlife populations, including vital species which are responsible for maintaining forest ecosystem services (Kelatwang and Garzuglia 2006; Brodie et al. 2015; Minhós et al. 2023).

Although Africa's forests are heavily exploited, with many relying on their resources, only ~9 % of these forests are protected under the International Union for Conservation of Nature (IUCN), with these protected areas being regarded as crucial for the conservation of wildlife (Kelatwang and Garzuglia 2006; Riggio et al. 2019). However, African nations are becoming increasingly aware of the importance of conserving ecological diversity and ecosystems, particularly since 1970, with an extensive network of protected areas being established (Newmark 2008). In sub-Saharan Africa alone, there are roughly 6390 protected areas, with there being 1100 national parks, with 36 of these parks being established World Heritage Sites; however, certain forested areas, such as Guinea and southern dry forests, are particularly lacking in protected area coverage (Newmark 2008; Chidumayo and Marunda 2010). Despite these positive actions towards conservation, wildlife species are still threatened by various anthropogenic activities in and outside these protected areas (Newmark 2008; Tyrrell et al. 2020).

South African forests are highly vulnerable to anthropogenic activities (Brown 2006; Colyn et al. 2020). Many were heavily exploited, particularly the Afromontane forests, since the settlement of Europeans in the country in 1652, with many large trees being felled for railway sleepers and furniture production (King 1940; Wirminghaus et al. 1999; Mucina et al. 2006; Adie et al. 2013). These intense logging practices were particularly prominent from 1870 – 1944, which worsened the fragmentation of these naturally fragmented forests (Wethered and Lawes 2003; Adie et al. 2013; Cooper et al. 2017). As a result of anthropogenic activities, approximately half of all the indigenous forests found in South Africa have become degraded, reducing the functionality of these environments (Cooper et al. 2017). Although many forests in South Africa have been given a protection status since the forming of a forest department in 1902, many of these forests are still harvested for natural resources, with many forests being damaged by over-grazing and trampling by introduced domestic cattle (Cooper and Moll 1968; Grieve and Downs 2015). Implementing effective conservation measures is challenging in South Africa because of the highly fragmented nature of these forests; however, by understanding the processes influencing forest changes, effective conservation strategies could be formed, particularly for those forests in anthropogenically modified environments (Lawes et al. 2000b; 2004; Rodríguez-Echeverry et al. 2018).

1.3 Habitat loss and fragmentation of natural forest landscapes

Habitat loss is simply the reduction in the amount of habitat, which is largely seen as being the biggest threat driving declines in biodiversity around the world (Hanski 2011; Banks-Leite et al. 2020; Gumede et al. 2022). Fragmentation of forests refers to the breaking up of continuous forests into smaller patches, quantified by changes in patch size, increased edge effects, and a reduction in connectivity (Liu et al. 2019; Banks-Leite et al. 2020). Fragmentation could be the result of numerous activities, which could be anthropogenic, such as road construction, fires, logging, conversion of habitat, or natural, such as variations in climate, causing the expansion or contraction of forest cover (Wade et al. 2003; Kotze and Lawes 2007). Forest fragmentation severely impacts species' distribution and presence, and further impacts their ecological interactions (Magrach et al. 2014). Fragmented landscapes are intricate because of the modified habitats surrounding these fragments (Pardini 2004). Connectivity between patches is thought to increase the closer the matrix habitat is to the fragmented landscape, resulting in varied species responses to the effects of fragmentation, with the overall effects being determined by scale, context and species of focus (Pardini 2004; Banks-Leite et al. 2020).

1.4 Island biogeography theory and habitat amount hypothesis

MacArthur and Wilson’s (1967) island biogeography theory (IBT) has been used in habitat fragmentation ecology as an analogy that habitat patches are similar to oceanic islands in that they are both surrounded by a harsh matrix (Bueno and Peres 2019). The theory postulates that immigration and extinction are the two processes determining the diversity of species on an island (Wu and Vankat 1995). As species diversity increases, the immigration rate decreases, with extinction rates increasing (Wu and Vankat 1995). The IBT suggests the colonisation of smaller islands occurs from the mainland, with increased isolation resulting in decreased immigration (Fahrig 2013). Increased isolation would thus cause the island to contain fewer, more closely related species, with larger island areas resulting in decreased extinction and increased diversity because of the greater diversity of habitat (Wu and Vankat 1995; Fahrig 2013; Helmus et al. 2014). An equilibrium is reached when the immigration rates and extinction rates are equal (Wu and Vankat 1995). However, this island-based theory applies to many discrete habitats, such as forest fragments, as they share similarities, with the IBT not being constrained by the scaling relationships of many biological processes characterising continental areas (Santos et al. 2016).

However, the IBT has received criticism as it does not adequately account for several factors which occur in fragmented landscapes, particularly in non island settings, with species being able to move between appropriate habitat patches, which do not present the same strong boundary exhibited by oceanic islands (Fahrig 2013; Bueno and Peres 2019). As a result, habitat patches cannot always be seen as discrete areas, with species-area relationships being governed at a spatial scale larger than those on habitat patch size (Bueno and Peres 2019).

The habitat amount hypothesis (HAH) opposes the IBT in that patches of habitat are not seen as separate entities, with immigration between habitat patches seen to occur from the habitat neighbouring the patch, not from a mainland, as stipulated by the IBT (Fahrig 2013; Haddad et al. 2017; Bueno and Peres 2019). In fragmented landscapes, the main mechanism determining the species-area relationships is suggested to be the overall sample area effect, as opposed to the island effect (Haddad et al. 2017; Seibold et al. 2017; Bueno and Peres 2019). Larger landscapes have greater amounts of surrounding habitat; therefore, they are predicted to house more species; however, the HAH assumes that species would view the overall landscape matrix as being functionally connected (Bueno and Peres 2019; Watling et al. 2020). Determining the accuracy of the HAH still requires further research as present research outcomes have produced results that have both supported or rejected the hypothesis, with original criticisms being made on the HAH being confined to those local landscapes with large areas of habitat (Bueno and Peres 2019).

Due to the popularity of the IBT in being used in habitat fragmentation ecology, with the HAH still requiring further research to determine its applicability in different landscapes (Bueno and Peres 2019), the IBT was the primary theory focused on in this study to describe the distribution patterns exhibited by the forest mammals in the Southern Mistbelt Forests in the Midlands of KwaZulu-Natal, South Africa.

1.5 Human-wildlife interactions and the impacts of forest loss

Humans cannot be separated from the environment, with a strong relationship between the two (Mori 2017). This is particularly the case for humans living near forests, as forests provide vital roles for the livelihoods of millions of people around the world by providing employment, food, energy and various ecological services (Maass et al. 2005; Mori 2017; Mallick and Chakraborty 2018; Sosibo et al. 2022a).

The benefits forests provide are increasingly threatened by human activities and population growth, with forest loss affecting the global carbon cycle, in which intact forests play a vital role, removing significant atmospheric CO_2 concentrations, thereby maintaining the atmospheric carbon balance (Zhang et al. 2007; Mori 2017; Maxwell et al. 2019). The removal of these carbon sinks would negatively impact the effects of global climate change, with the removal of these forests estimated to contribute between 7 – 15% of the anthropogenic CO_2 emissions globally, which contributes to the global rise in air temperatures (Chaparro and Terradas 2009; Netzer et al. 2019).

Forest loss also severely impacts slope stability, with high levels of soil erosion occurring, particularly on steeper slopes, resulting in gullying, landslides, and the overall increase of sediment entering the river systems (Bathurst et al. 2007). These can negatively impact humans by increasing the change of flash floods and landslides, as well as causing the sedimentation of reservoirs (Bathurst et al. 2007; Netzer et al. 2019). The conversion of forests to agricultural land results in the overall increase in surface water runoff, which can cause water pollution, as surface runoff from agricultural lands could introduce various organic or inorganic fertilisers into water sources, causing eutrophication because of the high nutrient contents of the surface water (Anju et al. 2010; Netzer et al. 2019). This could severely impact fisheries, with high eutrophication levels possibly being poisonous to humans (Netzer et al. 2019). The reduction of water infiltrating the earth’s surface because of higher surface runoff can negatively impact groundwater recharge rates, which could be particularly problematic during the dry season, with there possibly being water shortages (Netzer et al. 2019; Weatherl et al. 2021).

Increasing forest loss and degradation could also increase human-wildlife conflicts, particularly for those communities near forests, as forest loss causes wildlife and humans to be forced to exist in closer proximity to each other, forcing them to compete for resources (Acharya et al. 2017; Baral et al. 2021). This conflict occurs throughout the globe, which impacts the effectiveness of conservation measures, with instances of crop raiding often resulting in negative attitudes toward wildlife, particularly for communities that rely on agriculture for their livelihoods (Webber et al. 2007; Baral et al. 2021). These attitudes could severely impact the long-term success of conservation measures, particularly when authorities do not acknowledge the significance these crop-raiding animals have for the local communities (Webber et al. 2007), with this conflict potentially causing communities to kill these animals, regardless of whether they are regarded as threatened or endangered (Baral et al. 2021).

Due to species diversities playing a pivotal role in the functionality of ecological systems, the loss of species diversity, brought upon by anthropogenic activities, could have detrimental impacts on the ecosystem and human well-being (Mori 2017). Loss of diversity has one of the highest impacts on the functionality of earth’s ecosystems, with fragmentation, habitat loss and degradation, conversion of habitat to agricultural land, pollution and climate change, resulting from anthropogenic activities, being a primary cause for these losses, particularly in forests, which often contain higher levels of biodiversity than other terrestrial biomes (Mori 2017; Hill et al. 2019). In forests, hunting and timber removal are also seen as being primary causes for biodiversity loss, with many species being particularly sensitive to these changes, requiring an intact forest environment to survive, with the removal of vital species negatively impacting the functionality of these forests (Kelatwang and Garzuglia 2006;

Hill et al. 2019; Minhós et al. 2023). Deforestation has multiple negative impacts on human well-being, including the loss of goods and materials, such as food, and the loss of natural water purification and microclimate regulation (Mori 2017).

The type of activity causing forest loss is also seen as resulting in differing impacts on the forest, with logging activities being seen to reduce the quality of the habitat for many different taxa (Brodie et al. 2015). Logging results in an altering of the forest structure (Rist et al. 2012), such as the fragmentation of the forest canopy, creating gaps for sunlight to penetrate the forest, facilitating the growth of non-tree species (Edwards et al. 2014). These disturbances could result in invasive, non-native trees to establish within the forest, when the native tree species are removed (Brown and Gurevitch 2004). The results of logging are argued to be an overall loss of services and wildlife; however, some argue these forests still have high conservation value, with the majority of services and functions still intact (Edwards et al. 2014). However, resource extraction by local communities is a repeated harvesting practice that impacts forests' structure, diversity and composition (Thapa and Chapman 2010). This is particularly prominent in developing countries, where rural communities rely on forests for their livelihoods, regardless of the protection status of the forest (Thapa and Chapman 2010; Rist et al. 2012). Forests are primarily used as a source of fuelwood, food, medicinal products and general household equipment, with many relying on the forests for income (Rüger et al. 2008; Illukpitya and Yanagida 2010). Despite the extraction of resources being a repeated practice over a longer term, it is considered less damaging to conservation efforts than logging activities (Illukpitya and Yanagida 2010).

1.6 Occupancy modelling and camera trapping

Recently, technological and methodological advances have significantly improved the monitoring of wildlife (Devarajan et al. 2020). These technological advances have allowed more effective sampling of wild animal populations, with the use of several detectors (e.g., trail cameras), with methodological applications, particularly the use of occupancy models, allowing for the population assessment of threatened species, providing a probability that the species occurs at a site, whilst taking detectability into account (Bailey et al. 2014; Campos-Cerqueira and Aide 2016; Devarajan et al. 2020). Occupancy models also factor in the probability that the species may have been present at a particular site, although it was not detected, as well as the chance that species may have been misidentified, which is important, as without factoring in imperfect detectability, occupancy estimates can be underestimated, with inaccurate inferences being made regarding the relationship between habitat variables and the occurrence of the species of interest (MacKenzie and Bailey 2004; Bailey et al. 2014; Campos-Cerqueira and Aide 2016; Devarajan et al. 2020).

The development of these occupancy models has received significant attention since the original works by MacKenzie et al. (2002), with developed models accommodating multiple occupied states, with the need for studying communities of animals leading to the development of multi-species occupancy models (Bailey et al. 2014; Devarajan et al. 2020). Occupancy can generally be defined as the probability that a species of interest occupies a site over a particular timeframe, during which the state of occupancy does not change, with wildlife populations assumed to be geographically closed (Bailey et al. 2014; Rich et al. 2016). In each season, the occupancy state does not change, with repeated surveys allowing for the opportunity to identify the true occupancy state during a particular season (Bailey et al. 2014). However, these states of occupancy may change between seasons, with previously occupied sites becoming unoccupied and vice versa (Bailey et al. 2014). Occupancy models are thus designed to analyse the presence and absence of data across sites over a period of time, with the resulting models providing a robust estimate of species occurrence and general trends displayed over time (Outhwaite et al. 2018).

Camera traps have become a popular tool used to monitor wildlife by collecting species abundance or density data since the 1990s (Anile and Devillard 2016; Agha et al. 2018; Zwerts et al. 2021). Using camera traps to collect data on aspects such as population density, could be essential for conservation strategies, which could further aid in assessing the effectiveness of adopted management strategies (Balestrieri et al. 2016; Zwerts et al. 2021). The data collected can also be used to identify the impacts hunting and economic activities have on the demography of species (Balestrieri et al. 2016; Marracoli et al. 2019). Although camera traps have been used to monitor wildlife since the 20th century, their use in research has shown increased popularity over the past two decades (Galvis et al. 2014). Camera trap research on mammals originally focused on Felidae species, identifiable through their characteristic coat patterns (Anile and Devillard 2016). Since then, technological advances have greatly improved camera traps' performance while lowering their cost (Agha et al. 2018). These improvements led to the wide use of modern heat and/or motion-triggered camera traps (Swinnen et al. 2014) to collect abundance and density estimates for studying mammals (Anile and Devillard 2016; Fidino et al. 2020; Zwerts et al. 2021).

Camera traps have enabled biologists to effectively study those rare and elusive species, primarily found in remote areas, using a non-invasive, reliable and cost-effective method (Dupuis-Desormeaux et al. 2016; Ferreras et al. 2017; Dorning and Harris 2019; Thomas et al. 2020). Camera trapping is particularly advantageous as it allows data to be collected in the field for months, reducing the influence of human disturbance and animal stress in the area of interest (McCallum 2013). The camera traps operate 24 h day^{-1}, collecting data in those remote, potentially dangerous areas, covering a greater area than possible (compared with other methods if the same level of effort was used) (O'Brien 2008; McCallum 2013; Thomas et al. 2020). This is particularly useful for the study of those rare, nocturnal animals which live in low densities (McCallum 2013) or those species that are notoriously difficult to observe, such as those mammals found in forests (O'Brien 2008).

For camera traps to effectively achieve the aims of each study, the choice of sampling design is vital, with the appropriate selection being based on the biogeographic traits of the species in question (Brassine and Parker 2015), with sampling design choice determining the interpretation of results (Burton et al. 2015). When choosing installation locations for camera traps, the appropriate sampling design must be selected for the species of focus (Brassine and Parker 2015). Studies could choose targeted/deliberately-biased approaches, which focus on those locations which are easily accessible or are deemed to have likely animal presence (Meek et al. 2014; Burton et al. 2015; Hand et al. 2021). These focus areas could include nature trails, water bodies, road crossing structures, and fruiting trees or dens (Meek et al. 2014; Brassine and Parker 2015; Burton et al. 2015). The sampling design could also be systematic, focusing on specific spacing intervals between camera traps, or random sampling, with camera trap placement being determined by habitat or the general geography (Meek et al. 2014; Burton et al. 2015; Reece et al. 2021). For some studies to obtain the desired results, these sampling design options are sometimes combined (Meek et al. 2014).

Although camera traps have many advantages, their use is not entirely devoid of sampling errors (Burton et al. 2015). These errors could include those relating to the detection, whereby there is a false assumption that there is an equal chance that all species in the study area are detectable by the camera traps (Burton et al. 2015; Mann et al. 2015). This is often not the case, with certain species often not being detected by the camera traps even though they are known to occupy the sampling area (Rovero et al. 2013; Burton et al. 2015). This is particularly true for the detection of certain animal sizes, whereby camera placement could inhibit the ability of the camera to capture the animal (Kelly 2008; Meek et al. 2014). This error could also be related to the make and model of the camera trap used, as earlier models could fail to detect certain smaller species if the camera was placed too high, an error which seems to be rectified in the modern models (Kelly 2008; Burton et al. 2015). The failure of the camera trap to detect certain animals could also relate to the camera's trigger speed (e.g., where there is a delay between the animal entering the detection zone and the capture of the image). This could be problematic for detecting fast-moving animals, which could either be partially captured or not detected by the camera trap (Meek et al. 2014; Burton et al. 2015). Camera traps are also not wholly non-invasive, as their presence could cause certain species to have behavioural changes (Ferreras et al. 2018), which could cause some species to avoid the camera traps after their first capture completely (Maputla et al. 2013).

1.7 Importance of topic

Due to the several biodiversity hotspots in Africa (Agha et al. 2018), identifying areas of research focus throughout the continent, and the areas lacking attention, is essential, with this study highlighting the potential camera traps have in improving conservation efforts. By identifying these knowledge gaps, the need for conservation areas, and effective conservation strategies, will hopefully be realised, especially in light of the increasing rate of species extinction globally (Dirzo et al., 2022).

On the global scale, anthropogenic activities that impact the natural environments have led to species decline, and an understanding of how these pressures impact the persistence of biodiversity is vital for effective decision-making (Maseko et al. 2016; Ehlers Smith et al. 2018). In South Africa, the forest biome constitutes a small portion of the total land surface area, with patches of forest located along the southern and eastern seaboards (Lawes et al. 2007). The indigenous forests in southern Africa are declining because of natural and anthropogenic disturbances, resulting in fragmentation and alterations of ecosystem functions

(Lawes et al. 2007; Darkoh 2009). The history of these disturbances must be understood to determine the present ecology in these forests (Lawes et al. 2007).

The forests in KwaZulu-Natal face threats from anthropogenic land use and climate changes, with highly diverse fauna and flora in these regions (Ricketts and Shackleton 2020). These factors make this region fitting to determine taxonomic and functional diversity patterns, with loss of habitat being one of the most influential threats to the continued survival of several terrestrial species (Maseko et al. 2016; Ehlers Smith et al. 2017).

Determining the reasons for the distribution patterns of forest mammals and the processes impacting forest landscape changes is key to conservation planning, particularly in environments which have undergone anthropogenic disturbances (Lawes et al. 2004; Rodríguez-Echeverry et al. 2018). Small forest fragments are particularly important, as they are at a higher risk of biodiversity loss, with the loss of biodiversity having the potential to affect the overall forest dynamics, with the conservation of these forests being necessary to ensure these diversities can persist (Lawes et al. 2000b; Iezzi et al. 2018). In KwaZulu-Natal, the mammalian forest communities have not been extensively researched, and an improved understanding of how anthropogenic pressures impact the species residing in the limited forest habitats is imperative (Sosibo et al. 2022b).

1.8 Aim and objectives

The aim of this study was to assess the impacts anthropogenic activities have on mammalian forest presence in the Southern Mistbelt Forest patches in the Midlands of KwaZulu-Natal, South Africa. This was achieved through the following objectives:

1. Assessment of the impacts anthropogenic disturbances have on forest mammal presence in the Southern Mistbelt Forest patches in the Midlands of KwaZulu-Natal, South Africa, using camera traps and species occupancy modelling;

2. Assessment of the influence of historical pressures on microhabitat structure between the wet and dry seasons and how these impact the occupancy of bushbuck *Tragelaphus sylvaticus* and Cape porcupine *Hystrix africaeaustralis* in the Southern Mistbelt Forests of KwaZulu-Natal, South Africa;

3. Investigate the effects factors, such as patch size, patch isolation distance and landscape configuration (number of neighbouring forest patches) have on forest mammal species diversity, in the austral wet and dry seasons, within the Southern Mistbelt Forests of KwaZulu-Natal, South Africa.

1.9 Study outline

This thesis comprises five chapters, three of which are data chapters, which have either been published, or prepared for publication in relevant international peer-reviewed journals. There are instances of repetition in several of these chapters, which were unavoidable, particularly in the methods sections in those chapters using mammalian species composition data collected through the use of camera traps, as these data were used to answer different research questions and objectives. The hypotheses and/ or predictions are presented in the respective data chapters. The outline of the chapters in this thesis are:

Chapter 1: Introduction

Chapter 2: Camera trap research in Africa: A systematic review to show trends in wildlife monitoring and its value as a research tool

Chapter 3: Influence of historical pressures on the vegetation characteristics between the wet and dry season and their impacts on the occupancy of bushbuck and Cape porcupine within the Southern Mistbelt Forests of KwaZulu-Natal, South Africa

Chapter 4: Effect of seasonality and landscape factors on the occupancy of mammalian species within the Southern Mistbelt Forests of KwaZulu-Natal, South Africa

1.10 References

Acharya, K.P., Paudel, P.K., Jnawali, S.R., Neupane, P.R. & Koehl, M. (2017) Can forest fragmentation and configuration work as indicators of human–wildlife conflict? Evidences from human death and injury by wildlife attacks in Nepal. *Ecological Indicators*, **80**, 74-83.

Adie, H., Rushworth, I. & Lawes, M.J. (2013) Pervasive, long-lasting impact of historical logging on composition, diversity and above ground carbon stocks in Afrotemperate Forest. *Forest Ecology and Management*, **310**, 887–895.

Agha, M., Batter, T., Bolas, E.C., Collins, A.C., Gomes da Rocha, D., Monteza-Moreno, C.M., Preckler-Quisquater, S. & Sollmann, R. (2018) A review of wildlife camera trapping trends across Africa. *African Journal of Ecology*, **56**, 694-701.

Alencar, A., Nepstad, D. & Diaz, M.C.V. (2006) Forest understory fire in the Brazilian Amazon in ENSO and non-ENSO years: Area burned and committed carbon emissions. *Earth Interactions*, **10**, 1-17.

Almeida-Gomes, M. & Rocha, C.F.D. (2014) Landscape connectivity may explain anuran species distribution in an Atlantic forest fragmented area. *Landscape Ecology,* **29**, 29-40.

Anile, S. & Devillard, S. (2016) Study design and body mass influence RAIs from camera trap studies: evidence from the Felidae. *Animal Conservation*, **19**, 35–45.

Anju, A., Ravi S.P. & Bechan, S. (2010) Water pollution with special reference to pesticide contamination in India. *Journal of Water Resource and Protection*, **2**, 2010.

Aubréville, A.M.A. (2013) The disappearance of the tropical forests of Africa. *Fire Ecology*, **9**, 3-13.

Bailey, L.L., MacKenzie, D.I. & Nichols, J.D. (2014) Advances and applications of occupancy models. *Methods in Ecology and Evolution*, **5**, 1269-1279.

Balestrieri, A., Cardarelli, E., Pandini, M., Remonti, L., Saino, N. & Prigioni, C. (2016) Spatial organisation of European badger (*Meles Meles*) in northern Italy as assessed by camera-trapping. *European Journal of Wildlife Research*, **62**, 219–226.

Banks-Leite, C., Ewers, R.M., Folkard-Tapp, H. & Fraser, A. (2020) Countering the effects of habitat loss, fragmentation, and degradation through habitat restoration. *One Earth*, **3**, 672-676.

Baral, K., Sharma, H.P., Kunwar, R., Morley, C., Aryal, A., Rimal, B. & Ji, W. (2021) Human wildlife conflict and impacts on livelihood: A study in community forestry system in mid-hills of Nepal. *Sustainability*, **13**, 13170.

Bathurst, J.C., Moretti, G., El-Hames, A., Beguería, S. & García-Ruiz, J.M. (2007) Modelling the impact of forest loss on shallow landslide sediment yield, Ijuez River catchment, Spanish Pyrenees. *Hydrology and Earth System Sciences*, **11**, 569–583.

Bodart, C., Brink, A.B., Donnay, F., Lupi, A., Mayaux, P. & Achard, F. (2013) Continental estimates of forest cover and forest cover changes in the dry ecosystems of Africa between 1990 and 2000. *Journal of Biogeography*, **40**, 1036-1047.

Bodo, T., Gimah, B.G. & Seomoni, K.J. (2021) Deforestation and habitat loss: human causes, consequences and possible solutions. *Journal of Geographical Research*, **4**, 22-30.

Brassine, E. & Parker, D. (2015) Trapping elusive cats: using intensive camera trapping to estimate the density of a rare African felid. *PLoS ONE*, **10**, e0142508.

Brodie, J.F., Giordano, A.J., Zipkin, E.F., Bernard, H., Mohd-Azlan, J. & Ambu, L. (2015) Correlation and persistence of hunting and logging impacts on tropical rainforest mammals. *Conservation Biology*, **29**, 110-121.

Brown, K.A. & Gurevitch, J. (2004) Long-term impacts of logging on forest diversity in Madagascar. *Proceedings of the National Academy of Sciences*, **101**, 6045-6049.

Brown, M. (2006) Annual and seasonal trends in avifaunal species richness in a coastal lowlands forest reserve in South Africa. *Ostrich,* **77**, 58-66.

Bueno, A.S. & Peres, C.A. (2019) Patch-scale biodiversity retention in fragmented landscapes: reconciling the habitat amount hypothesis with the island biogeography theory. *Journal of Biogeography*, **46**, 621-632.

Bullock, E.L., Healey, S.P., Yang, Z., Oduor, P., Gorelick, N., Omondi, S., Ouko, E. & Cohen, W.B. (2021) Three decades of land cover change in East Africa. *Land*, **10**, 150.

Burton, A.C., Neilson, E., Moreira, D., Ladle, A., Steenweg, R., Fisher, J.T., Bayne, E. & Boutin, S., 2015. Wildlife camera trapping: a review and recommendations for linking surveys to ecological processes. *Journal of Applied Ecology*, **52**, 675-685.

Campos-Cerqueira, M. & Aide, T.M. (2016) Improving distribution data of threatened species by combining acoustic monitoring and occupancy modelling. *Methods in Ecology and Evolution*, **7**, 1340-1348.

Chaparro, L. & Terradas, J. (2009) [PDF] Ecological Services of urban forest in Barcelona: Semantic scholar. URL https://www.semanticscholar.org/paper/Ecological-services-of-urban-forest-in-Barcelona-Chaparro Terradas.

Chidumayo, E.N. & Gumbo, D.J. (2013) Biodiversity of Plants. *The Dry Forests and Woodlands of Africa: Managing for products and Services,* pp. 43–61. Routledge, London.

Colyn, R.B., Ehlers Smith, D.A., Ehlers Smith, Y.C., Smit-Robinson, H. & Downs, C.T. (2020) Predicted distributions of avian specialists: a framework for conservation of endangered forests under future climates. *Diversity and Distributions*, **26**, 652-667.

Cooper, K.H. & Moll, E.J. (1968) *Some Notes on an Area of the Karkloof Forest, Natal*. Wildlife Protection and Conservation Society, Natal Fieldwork Section, Durban.

Cooper, T.J., Wannenburgh, A.M. & Cherry, M.I. (2017) Atlas data indicate forest dependent bird species declines in South Africa. *Bird Conservation International*, **27**, 337–354.

Curtis, P.G., Slay, C.M., Harris, N.L., Tyukavina, A. & Hansen, M.C. (2018) Classifying drivers of global forest loss. *Science,* **361**, 1108-1111.

Darkoh, M.B.K. (2009) An overview of environmental issues in Southern Africa. *African Journal of Ecology*, **47**, 93-98.

Devarajan, K., Morelli, T.L. & Tenan, S. (2020) Multi-species occupancy models: review, roadmap, and recommendations. *Ecography*, **43**, 1612-1624.

Dirzo, R., Ceballos, G. & Ehrlich, P.R. (2022) Circling the drain: The extinction crisis and the future of humanity. *Philosophical Transactions of the Royal Society B,* **377**, 20210378.

Dorning, J. & Harris, S. (2019) The challenges of recognising individuals with few distinguishing features: identifying red foxes *Vulpes vulpes* from camera-trap photos. *PLoS ONE*, **14**, e0216531.

Dupuis-Desormeaux, M., Davidson, Z., Mwololo, M., Kisio, E. & MacDonald, S.E. (2016) Comparing motion capture cameras versus human observer monitoring of mammal movement through fence gaps: a case study from Kenya. *African Journal of Ecology*, **54**, 154-161.

Edwards, D.P., Tobias, J.A., Sheil, D., Meijaard, E. & Laurance, W.F. (2014) Maintaining ecosystem function and services in logged tropical forests. *Trends in Ecology & Evolution*, **29**, 511-520.

Ehlers Smith, Y.C, Ehlers Smith, D.A, Ramesh, T. & Downs, C.T. (2017) The importance of microhabitat structure in maintaining forest mammal diversity in a mixed land-use mosaic. *Biodiversity and Conservation*, **26**, 2361-2382.

Ehlers Smith, Y.C., Ehlers Smith, D.A., Ramesh, T. & Downs, C.T. (2018) Forest habitats in a mixed urban-agriculture mosaic landscape: patterns of mammal occupancy. *Landscape Ecology*, **33**, 59-76.

Ellis, E.C. & Ramankutty, N. (2008) Putting people in the map: anthropogenic biomes of the world. *Frontiers in Ecology and the Environment*, **6**, 439-447.

Fahrig, L. (2013) Rethinking patch size and isolation effects: the habitat amount hypothesis. *Journal of Biogeography*, **40**, 1649–1663.

Farwig, N., Sajita, N. & Böhning-Gaese, K. (2008) Conservation value of forest plantations for bird communities in western Kenya. *Forest Ecology and Management*, **255**, 3885-3892.

Ferreras, P., Díaz-Ruiz, F., Alves, P.C. & Monterroso, P. (2017) Optimizing camera-trapping protocols for characterizing mesocarnivore communities in south-western Europe. *Journal of Zoology*, **301**, 23-31.

Ferreras, P., Díaz-Ruiz, F. & Monterroso, P. (2018) Improving mesocarnivore detectability with lures in camera-trapping studies. *Wildlife Research*, **45**, 505-517.

Fidino, M., Barnas, G.R., Lehrer, E.W., Murray, M.H. & Magle, S.B. (2020) Effect of lure on detecting mammals with camera traps. *Wildlife Society Bulletin*, **44**, 543-552.

Fischer, R., Taubert, F., Müller, M.S., Groeneveld, J., Lehmann, S., Wiegand, T. & Huth, A. (2021) Accelerated forest fragmentation leads to critical increase in tropical forest edge area. *Science Advances*, **7**, eabg7012.

Galvis, N., Link, A. & Di Fiore, A. (2014) A novel use of camera traps to study demography and life history in wild animals: a case study of spider monkeys (*Ateles belzebuth*). *International Journal of Primatology*, **35**, 908-918.

Giam, X. (2017) Global biodiversity loss from tropical deforestation. *Proceedings of the National Academy of Sciences*, **114**, 5775-5777.

Grieve, G.R.H. & Downs, C.T. (2015) A checklist of the plants of the forests and grasslands in the Weza district, southern KwaZulu-Natal and a review of their status in the Red Data List. *Koedoe*, **57**, 1-7.

Gumede, S.T., Ehlers Smith, D.A., Ngcobo, S.P., Sosibo, M., Ehlers Smith, Y.C. & Downs, C.T. (2022) The influence of forest characteristics on avian species richness and functional diversity in southern mistbelt forests of South Africa. *Global Ecology and Conservation*, **34**, e02047.

Haddad, N.M., Gonzalez, A., Brudvig, L.A., Burt, M.A., Levey, D.J. & Damschen, E.I. (2017) Experimental evidence does not support the habitat amount hypothesis. *Ecography*, **40**, 48-55.

Hand, C.E., Gabel, W., Dipetto, G.R., Bonafilia, R.E., Thibault, J.M. & Znidersic, E. (2021) A window into the breeding ecology and molt of the Eastern Black Rail (*Laterallus jamaicensis jamaicensis*). *Waterbirds*, **44**, 207-221.

Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O. & Townshend, J. (2013) High-resolution global maps of 21st-century forest cover change. *Science*, **342**, 850-853.

Hanski, I. (2011) Habitat loss, the dynamics of biodiversity, and a perspective on conservation. *Ambio*, **40**, 248-255.

Heino, M., Kummu, M., Makkonen, M., Mulligan, M., Verburg, P.H., Jalava, M. & Räsänen, T.A. (2015) Forest loss in protected areas and intact forest landscapes: a global analysis. *PLoS ONE*, **10**, e0138918.

Helmus, M.R., Mahler, D.L. & Losos, J.B. (2014) Island biogeography of the Anthropocene. *Nature*, **513**, 543-546.

Hill, S.L., Arnell, A., Maney, C., Butchart, S.H., Hilton-Taylor, C., Ciciarelli, C., Davis, C., Dinerstein, E., Purvis, A. & Burgess, N.D. (2019) Measuring forest biodiversity status and changes globally. *Frontiers in Forests and Global Change*, **2**, 70.

Iezzi, M.E., Cruz, P., Varela, D., De Angelo, C. & Di Bitetti, M.S. (2018) Tree monocultures in a biodiversity hotspot: Impact of pine plantations on mammal and bird assemblages in the Atlantic Forest. *Forest Ecology and Management*, **424**, 216–227.

Illukpitiya, P. & Yanagida, J.F. (2010) Farming vs forests: Trade-off between agriculture and the extraction of non-timber forest products. *Ecological Economics*, **69**, 1952-1963.

Kelatwang, S. & Garzuglia, M. (2006) Changes in forest area in Africa 1990-2005. *International Forestry Review*, **8**, 21-30.

Kelly, M.J. (2008) Design, evaluate, refine: camera trap studies for elusive species. *Animal Conservation*, **11**, 182-184.

Kormos, C.F., Mackey, B., DellaSala, D.A., Kumpe, N., Jaeger, T., Mittermeier, R.A. & Filardi, C. (2017) Primary forests: definition, status and future prospects for global conservation. *Encyclopedia of the Anthropocene*, **2**, 31-41.

Kotze, D.J. & Lawes, M.J. (2007) Viability of ecological processes in small Afromontane forest patches in South Africa. *Austral Ecology*, **32**, 294–304.

Lampila, P., Mönkkönen, M. & Desrochers, A. (2005) Demographic responses by birds to forest fragmentation. *Conservation Biology*, **19**, 1537-1546.

Lawes, M.J., Eeley, H.A., Findlay, N.J. & Forbes, D. (2007) Resilient forest faunal communities in South Africa: a legacy of palaeoclimatic change and extinction filtering? *Journal of Biogeography*, **34**, 1246–1264.

Lawes, M.J., Eeley, H.A. & Piper, S.E. (2000a) The relationship between local and regional diversity of indigenous forest fauna in KwaZulu-Natal Province, South Africa. *Biodiversity and Conservation*, **9**, 683-705.

Lawes, M.J., Lamb, B.C.C. & Boudreau, S. (2005) Area- but no edge-effect on woody seedling abundance and species richness in old Afromontane forest fragments. *Journal of Vegetation Science*, **16**, 363.

Lawes, M.J., MacFarlane, D.M. & Eeley, H.A. (2004) Forest landscape pattern in the KwaZulu-Natal midlands, South Africa: 50 years of change or stasis? *Austral Ecology*, **29**, 613–623.

Lawes, M.J., Mealin, P.E. & Piper, S.E. (2000b) Patch occupancy and potential metapopulation dynamics of three forest mammals in fragmented Afromontane forest in South Africa. *Conservation Biology*, **14**, 1088–1098.

Liu, J., Coomes, D.A., Gibson, L., Hu, G., Liu, J., Luo, Y., Wu, C. & Yu, M. (2019) Forest fragmentation in China and its effect on biodiversity. *Biological Reviews*, **94**, 1636–1657.

Maass, J.M., Balvanera, P., Castillo, A., Daily, G.C., Mooney, H.A., Ehrlich, P., Quesada, M., Miranda, A., Jaramillo, V.J., García-Oliva, F., Martínez-Yrizar, A., Cotler, H., López-Blanco, J., Pérez-Jiménez, A., Búrquez, A., Tinoco, C., Ceballos, G., Barraza, L., Ayala, R. & Sarukhán, J. (2005) Ecosystem services of tropical dry forests: insights from long-term ecological and social research on the Pacific coast of Mexico. *Ecology and Society*, **10**, 1-24.

MacArthur, R.H. & Wilson, E.O. (1967) *The Theory of Island Biogeography*. Princeton University Press, Princeton.

MacKenzie, D.I. & Bailey, L.L. (2004) Assessing the fit of site-occupancy models. *Journal of Agricultural, Biological, and Environmental Statistics*, **9**, 300-318.

MacKenzie, D.I., Nichols, J.D., Lachman, G.B., Droege, S., Royle, A.J. & Langtimm, C.A. (2002) Estimating site occupancy rates when detection probabilities are less than one. *Ecology*, **83**, 2248–2255.

Magrach, A., Laurance, W.F., Larrinaga, A.R. & Santamaria, L. (2014) Meta-analysis of the effects of forest fragmentation on interspecific interactions. *Conservation Biology*, **28**, 1342-1348.

Mallick, P.H. & Chakraborty, S.K. (2018) Forest, wetland and biodiversity: Revealing multi-faceted ecological services from ecorestoration of a degraded tropical landscape. *Ecohydrology & Hydrobiology*, **18**, 278-296.

Mangwale, K., Shackleton, C.M. & Sigwela, A. (2017) Changes in forest cover and carbon stocks of the coastal scarp forests of the Wild Coast, South Africa. *Southern Forests: A Journal of Forest Science*, **79**, 305-315.

Mann, G.K., O'Riain, M.J. & Parker, D.M. (2015) The road less travelled: assessing variation in mammal detection probabilities with camera traps in a semi-arid biodiversity hotspot. *Biodiversity and Conservation*, **24**, 531-545.

Maputla, N.W., Chimimba, C.T. & Ferreira, S.M. (2013) Calibrating a camera trap–based biased mark–recapture sampling design to survey the leopard population in the N'wanetsi concession, Kruger National Park, South Africa. *African Journal of Ecology*, **51**, 422-430.

Marrocoli, S., Nielsen, M.R., Morgan, D., van Loon, T., Kulik, L. & Kühl, H. (2019) Using wildlife indicators to facilitate wildlife monitoring in hunter-self monitoring schemes. *Ecological Indicators*, **105**, 254-263.

Maseko, M.S., Ramesh, T., Kalle, R. & Downs, C.T. (2016) Response of Crested Guinea-fowl (*Guttera edouardi*), a forest specialist, to spatial variation in land use in iSimangaliso Wetland Park, South Africa. *Journal of Ornithology*, **158**, 469-477.

Maxwell, S.L., Evans, T., Watson, J.E., Morel, A., Grantham, H., Duncan, A., Harris, N., Potapov, P., Runting, R.K., Venter, O., Wang, S. & Malhi, Y. (2019) Degradation and forgone removals increase the carbon impact of intact forest loss by 626%. *Science Advances*, **5**, eaax2546.

McCallum, J. (2013) Changing use of camera traps in mammalian field research: habitats, taxa and study types. *Mammal Review*, **43**, 196-206.

Meek, P.D., Ballard, G., Claridge, A., Kays, R., Moseby, K., O'Brien, T., O'Connell, A., Sanderson, J., Swann, D.E., Tobler, M. & Townsend, S. (2014) Recommended guiding principles for reporting on camera trapping research. *Biodiversity and Conservation*, **23**, 2321-2343.

Meyfroidt, P. & Lambin, E.F. (2011) Global forest transition: prospects for an end to deforestation. *Annual Review of Environment and Resources*, **36**, 343-371.

Minhós, T., Borges, F., Parreira, B., Oliveira, R., Aleixo-Pais, I., Leendertz, F.H., Wittig, R., Fernandes, C.R., Marques Silva, G.H., Duarte, M., Bruford, M.W., Ferreira da Silva, M.J. & Chikhi, L. (2023) The importance of well protected forests for the conservation genetics of West African Colobine Monkeys. *American Journal of Primatology*, **85**, e23453.

Mithal, V., Garg, A., Boriah, S., Steinbach, M., Kumar, V., Potter, C., Klooster, S. & Castilla-Rubio, J.C. (2011) Monitoring global forest cover using data mining. *ACM Transactions on Intelligent Systems and Technology (TIST)*, **2**, 1-24.

Moir, M.I., Richards, L.R., Rambau, R.V. & Cherry, M.I. (2020) Bats of Eastern Cape and southern KwaZulu-Natal forests, South Africa: diversity, call library and range extensions. *Acta Chiropterologica*, **22**, 365-381.

Moomaw, W.R., Law, B.E. & Goetz, S.J. (2020) Focus on the role of forests and soils in meeting climate change mitigation goals: summary. *Environmental Research Letters*, **15**, 045009.

Mori, A.S. (2017) Biodiversity and ecosystem services in forests: management and restoration founded on ecological theory. *Journal of Applied Ecology*, **54**, 7-11.

Mucina, L., Geldenhuys, C.J. & Rutherford, M.C. (2006) Afrotemperate, subtropical and azonal forests. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia*, **19**, 584-614.

Mulvaney, J.M., Cherry, M.I. & Matthee, C.A. (2022) Climate refugia for three Afromontane forest-dependent bird species in south-eastern South Africa. *Journal of Biogeography*, **49**, 1352-1366.

Netzer, M.S., Sidman, G., Pearson, T.R., Walker, S.M. & Srinivasan, R. (2019) Combining global remote sensing products with hydrological modelling to measure the impact of tropical forest loss on water-based ecosystem services. *Forests*, **10**, 413.

Newmark, W.D. (2008) Isolation of African protected areas. *Frontiers in Ecology and the Environment*, **6**, 321-328.

Norris, K., Asase, A., Collen, B., Gockowksi, J., Mason, J., Phalan, B. & Wade, A. (2010) Biodiversity in a forest-agriculture mosaic–The changing face of West African rainforests. *Biological Conservation*, **143**, 2341-2350.

O'Brien, T.G. (2008) On the use of automated cameras to estimate species richness for large- and medium-sized rainforest mammals. *Animal Conservation*, **11**, 179-181.

Outhwaite, C.L., Chandler, R.E., Powney, G.D., Collen, B., Gregory, R.D. & Isaac, N.J. (2018) Prior specification in Bayesian occupancy modelling improves analysis of species occurrence data. *Ecological Indicators*, **93**, 333-343.

Pardini, R. (2004) Effects of forest fragmentation on small mammals in an Atlantic Forest landscape. *Biodiversity & Conservation*, **13**, 2567-2586.

Prach, K. & Walker, L.R. (2020) *Comparative Plant Succession among Terrestrial Biomes of the World*. Cambridge University Press, Cambridge.

Reece, S.J., Radloff, F.G., Leslie, A.J., Amin, R. & Tambling, C.J. (2021) A camera trap appraisal of species richness and community composition of medium and large mammals in a Miombo woodland reserve. *African Journal of Ecology*, **59**, 898-911.

Rich, L.N., Miller, D.A., Robinson, H.S., McNutt, J.W. & Kelly, M.J. (2016) Using camera trapping and hierarchical occupancy modelling to evaluate the spatial ecology of an African mammal community. *Journal of Applied Ecology*, **53**, 1225-1235.

Ricketts, K. & Shackleton, C.M. (2020) Integrating livelihoods and forest conservation through beekeeping in northern KwaZulu-Natal. *Development Southern Africa*, **37**, 661-677.

Riggio, J., Jacobson, A.P., Hijmans, R.J. & Caro, T. (2019) How effective are the protected areas of East Africa? *Global Ecology and Conservation*, **17**, e00573.

Rist, L., Shanley, P., Sunderland, T., Sheil, D., Ndoye, O., Liswanti, N. & Tieguhong, J. (2012) The impacts of selective logging on non-timber forest products of livelihood importance. *Forest Ecology and Management*, **268**, 57-69.

Ritchie, H. & Roser, M. (2021) Deforestation and forest loss. URL https://ourworldindata.org/deforestation [accessed 24 April 2023]

Rodríguez-Echeverry, J., Fuentes, R., Leiton, M. & Jaque, E. (2018) Changing landscapes forest: implications for its conservation. *Environment and Natural Resources Research*, **8**, 44.

Rovero, F., Collett, L., Ricci, S., Martin, E. & Spitale, D. (2013) Distribution, occupancy, and habitat associations of the gray-faced sengi (*Rhynchocyon udzungwensis*) as revealed by camera traps. *Journal of Mammalogy*, **94**, 792-800.

Rüger, N., Williams-Linera, G., Kissling, W.D. & Huth, A. (2008) Long-term impacts of fuelwood extraction on a tropical montane cloud forest. *Ecosystems*, **11**, 868-881.

Santos, A.M., Field, R. & Ricklefs, R.E. (2016) New directions in island biogeography. *Global Ecology and Biogeography*, **25**, 751-768.

Seibold, S., Bässler, C., Brandl, R., Fahrig, L., Förster, B., Heurich, M., Hothorn, T., Scheipl, F., Thorn, S. & Müller, J. (2017) An experimental test of the habitat-amount hypothesis for saproxylic beetles in a forested region. *Ecology*, **98**, 1613–1622.

Sosibo, M.T., Ehlers Smith, Y.C., Ehlers Smith, D.A. & Downs, C.T. (2022a) Some perspectives on the use and value of Southern Mistbelt Forests to surrounding rural communities in northern Eastern Cape, and southern KwaZulu-Natal, South Africa. *African Journal of Wildlife Research*, **52**, 103-121.

Sosibo, M.T., Ehlers Smith, D.A., Ehlers Smith, Y.C., Gumede, S.T., Ngcobo, S.P. & Downs, C.T. (2022b) Mammalian assemblages in southern mistbelt forests of the northern Eastern Cape, and southern KwaZulu-Natal provinces, South Africa, and their response to bordering land-use. *Mammalian Biology*, **102**, 429-440.

Stork, N.E., Coddington, J. A., Colwell, R.K., Chazdon, R.L., Dick, C.W., Peres, C.A., Sloan, S. & Willis, K. (2009) Vulnerability and resilience of tropical forest species to land-use change. *Conservation Biology*, **23**, 1438-1447.

Swinnen, K.R., Reijniers, J., Breno, M. & Leirs, H. (2014) A novel method to reduce time investment when processing videos from camera trap studies. *PLoS ONE*, **9**, e98881.

Thapa, S. & Chapman, D.S. (2010) Impacts of resource extraction on forest structure and diversity in Bardia National Park, Nepal. *Forest Ecology and Management*, **259**, 641-649.

Thomas, M.L., Baker, L., Beattie, J.R. & Baker, A.M. (2020) Determining the efficacy of camera traps, live capture traps, and detection dogs for locating cryptic small mammal species. *Ecology and Evolution*, **10**, 1054-1068.

Tyrrell, P., du Toit, J.T. & Macdonald, D.W. (2020) Conservation beyond protected areas: using vertebrate species ranges and biodiversity importance scores to inform policy for an East African country in transition. *Conservation Science and Practice*, **2**, e136.

Wade, T.G., Riitters, K.H., Wickham, J.D. & Jones, K.B. (2003) Distribution and causes of global forest fragmentation. *Conservation Ecology*, **7**, 7.

Watling, J.I., Arroyo-Rodríguez, V., Pfeifer, M., Baeten, L., Banks-Leite, C., Cisneros, L.M., Fang, R., Hamel-Leigue, A.C., Lachat, T., Leal, I.R., Lens, L., Possingham, H.P., Raheem, D.C., Ribeiro, D.B., Slade, E.M., Urbina-Cardona, J.N., Wood, E.M. & Fahrig, L. (2020) Support for the habitat amount hypothesis from a global synthesis of species density studies. *Ecology Letters*, **23**, 674–681.

Weatherl, R.K., Henao Salgado, M.J., Ramgraber, M., Moeck, C. & Schirmer, M. (2021) Estimating surface runoff and groundwater recharge in an urban catchment using a water balance approach. *Hydrogeology Journal*, **29**, 2411-2428.

Webber, A.D., Hill, C.M. & Reynolds, V. (2007) Assessing the failure of a community-based human-wildlife conflict mitigation project in Budongo Forest Reserve, Uganda. *Oryx*, **41**, 177-184.

Wethered, R. & Lawes, M.J. (2003) Matrix effects on bird assemblages in fragmented Afromontane forests in South Africa. *Biological Conservation*, **114**, 327–340.

Wu, J. & Vankat, J.L. (1995) Island biogeography: theory and applications. *Encyclopedia of Environmental Biology*, **2**, 371-379.

Zhang, J., Ge, Y., Chang, J., Jiang, B., Jiang, H., Peng, C., Zhu, J., Yuan, W., Qi, L. & Yu, S. (2007) Carbon storage by ecological service forests in Zhejiang province, subtropical China. *Forest Ecology and Management*, **245**, 64–75.

Zwerts, J.A., Stephenson, P.J., Maisels, F., Rowcliffe, M., Astaras, C., Jansen, P.A., Waarde, J., Sterck, L.E., Verweij, P.A., Bruce, T., Brittain, S. & Kuijk, M. (2021) Methods for wildlife monitoring in tropical forests: comparing human observations, camera traps, and passive acoustic sensors. *Conservation Science and Practice*, **3**, e568.

CHAPTER 2

Camera trap research in Africa: A systematic review to show trends in wildlife monitoring and its value as a research tool

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Running header: Camera trap research in Africa

2.1 Abstract

Camera traps have been used increasingly as a research tool to monitor wildlife globally, and have become more advanced, thereby improving their performance and lowering costs. Their use has allowed researchers to study a range of species, including rare and elusive species, particularly in remote areas, in a non-invasive, reliable and cost-effective way. In this review, we sought to document the camera trapping research on terrestrial wildlife conducted in Africa, identifying countries and habitat types of focus, and how these camera trap research trends in Africa could be improved in the future. Through a systematic literature search, we found 408 peer-reviewed publications using camera traps to study terrestrial wildlife in Africa, with the first being in 2005 and up to 2021. Although camera trap studies were conducted in 38 African countries, most were in South Africa (28.9%). Most studies assessed the occupancy of species (41.4%). The studies covered a range of taxa, with mammals being the most popular. The majority of research focussed on large carnivores (24.8%), with a particular focus on leopards (*Panthera pardus*) (60 studies). Most studies (43.9%) focused on a single species, with forests (174 studies, 42.6%) and savannah/bushveld (145 studies, 35.5%) being the habitat type of focus. There was also a strong preference for camera trap studies to be conducted in protected areas (68.9%). The camera trap methods used varied considerably between studies, which included: the number of camera trap stations, survey length, trap effort, camera trap make and model, camera trap flash type, interval delay, camera multishot, height of camera trap placement, camera trap layout method and whether the camera trap was baited. These variations are expected because of the difference in research goals posed by each study. However, studies with similar objectives and/or focus still display a clear lack of standardisation (studies do not conform to a specific standard), which could negatively impact the results obtained, as inappropriate camera trap protocols could affect the detectability of certain species. Future camera trap studies will hopefully extend to countries and taxa that have received little attention, with further research informing appropriate conservation strategies that could reduce the threats to biodiversity.

Keywords: camera traps; monitor wildlife; terrestrial wildlife; large carnivore; forest; protocols

2.2 Introduction

Africa is highly rich in biodiversity, comprising a range of habitat types, from dry deserts to tropical rainforests (Klopper et al., 2002). Biodiversity losses worldwide are primarily the result of anthropogenic habitat loss, fragmentation, land-use change, and increased population growth, with biodiversity being the most impacted in the hotspots located in tropical Africa and regions in Asia (Bach and Kelly, 2004; dos Anjos et al., 2011; Batáry et al., 2014; Aben et al., 2016; Habel et al., 2019; Alexander et al., 2019).

Since the early 20th century, camera traps have been used for research and wildlife investigations and monitoring (Rowcliffe and Carbone, 2008; Agha et al., 2018); however, the use of camera traps in research has shown a drastic increase over the past two decades (Galvis et al., 2014). Camera traps are a highly useful tool for the monitoring of biodiversity, which is essential for identifying those areas in need of conservation strategies (Mann et al., 2015; Dupuis-Désormeaux et al., 2016a,b; Ferreras et al., 2017). Obtaining population size estimates of different species, although a historical challenge, is necessary to assess the effectiveness of conservation measures and to shape the direction of future management (Burton et al., 2015; Ramesh et al., 2016a,b; Chauvenet et al., 2017). Camera trapping could be especially useful in Africa and Europe, which received the least camera trap studies in previous reviews, especially with Africa lacking information on its biodiversity, with most taxa receiving relatively little attention (Klopper et al., 2002; Burton et al., 2015).

Camera trap strategies used will depend on several factors. Each study incorporating camera traps will strategise data collection based on the research question posed, the species of focus, the conservation status of the species and the resources available to the study (Roberts, 2011; Meek et al., 2015). However, although each study will shape the sampling design based on these factors, a level of standardisation is necessary to ensure the aims of each study are effectively achieved, with appropriate sampling designs being essential for the interpretation of results (Brassine and Parker, 2015; Burton et al., 2015; Rich et al., 2019). This standardisation could relate to the settings and camera trap placement procedures used, as there is great variability in camera trap settings available, which could include trigger speed, image quality, number of images per capture and passive infrared sensitivity (Meek et al., 2015). These settings, coupled with the height of the installed camera trap, are important, as they can lead to misinterpretations of results because of the effect these factors have on detection (Meek et al., 2015).

Our objective of this review was to assess the camera trap publications conducted in Africa and their use as a research tool. Global camera trap research has primarily been conducted on the continents of Asia (28.6%), North America (28.8%), and South America (23.0%), with far fewer studies being conducted in Africa (12.3%), which houses several biodiversity hotspots (Agha et al., 2018; Burton et al., 2015). Here, we reviewed camera trap studies conducted in Africa with the purpose of identifying the popularity of camera traps since their first use, the countries of focus (and those which have lacked attention), the species focus of the research (i.e., whether the study focused on particular taxa or species), the study objectives, the habitat and land use type of focus and the camera trap methods chosen. We also investigated whether there was any standardisation of procedures, particularly for certain species or species assemblages.

2.3 Methods

2.3.1 Data collection

We conducted a systematic literature search on camera trap based research in Africa over time up until the end of 2021 using the Web of Science^{TM} and Scopus search engines on 10 April 2022 and 30 May 2022, respectively. The search strings used for this review identified internationally peer-reviewed journal publications and conference proceedings of camera trap research across all African countries. To obtain these publications, we used the term ‘camera trap’ in the search string, along with six similar terms (remote camera, infrared triggered camera, trail camera, automatic camera, photo trap, remotely triggered camera), to ensure all relevant research was gathered. Each country in Africa was individually listed in the respective search strings used. The results for each publication were recorded in a Microsoft Excel spreadsheet. The search string used was not limited to publication date, ensuring all camera trap publications conducted in Africa were included, with the first detected study being published in 2005. We used a range of search strings (Supplementary information Table S2.1), which included the Web of Science^{TM} and Scopus search phases, which were kept consistent to ensure repeatability, with the generated results recorded.

2.3.2 Analyses of camera trap study design and use

To investigate the various applications of camera traps, we recorded and summarised a range of variables. These included the year of publication, data capture methods (e.g. camera traps, line transects, etc.), the number of focal species (single, multiple, community), the species or general taxon of focus, study objectives (behavioural/ observations, occupancy (which includes density, population dynamics/ distribution and habitat use), demographics (e.g. species composition, sex, etc.) and multiple objectives), country the study was conducted in, description of the study area, the camera trap layout selected (random, systematic, deliberately-biased), the number of camera trap stations, the trap effort (number of camera traps x the number of days operational), the survey length (duration of the camera trap study), whether the cameras were baited, the habitat type (e.g. forest, grassland, etc.), land use type of the study area (protected area, e.g. National Park, farmland/ community managed land/ concession/ plantations, protected and unprotected areas, unprotected/ development/ urban, farmland and protected areas, unknown) and if the study was conducted in a biodiversity hotspot (Supplementary information Table S2.2). A biodiversity hotspot was considered to be those regions listed as a part of the 36 global biodiversity hotspots, with eight hotspots being listed across Africa (Habel et al., 2019). In addition, the study design variables for each study were recorded and assessed for trends relating to the approach used to collect data, as the design chosen for a study could have important consequences for the collection of data from the survey (Burton et al., 2015; Brassine and Parker, 2015). More detailed information on all the variables recorded can be found in the supplementary data (Supplementary information Tables S2.2-S2.9).

2.3.3 Analyses of camera trap protocols

For each included publication, we recorded the camera trap make and model, as well as the camera settings and installation procedures used. These included the type of camera flash (infrared, xenon/ strobe flash, white flash/ white LED/ incandescent, film, black/ no glow), the image quality, the camera trap's trigger time, the interval delay between camera trap triggers, camera multishot, whether a video was recorded, and the height that the camera trap was installed (Supplementary information Table S2.8). The settings and installation procedures used are important as they can influence the detectability of a species and the ability to repeat the results collected (Meek et al., 2014; Burton et al., 2015). This information was also collected to identify trends and possible standardisation of camera trap protocols, which provides a form of consistency between studies (Meek et al., 2014).

2.3.4 Inclusion and exclusion criteria

Any published peer-reviewed African study that collected data through the use of camera traps was included in our review, regardless of whether there were multiple data collection methods. The research publication date needed to be conducted on any terrestrial animals in Africa from the first publication to include the use of camera traps (2005) to the end of 2021. The researchers needed to collect and present their own findings from the use of camera traps, meaning published articles that presented the data obtained from other studies were not included. Short communications, conference proceedings and notes and records that were published in a peer-reviewed journal were also included.

The following types of publications were excluded from the review: 1) Studies that did not collect data through the use of camera traps; 2) publications that focused on methodological testing of camera trap equipment; 3) studies conducted in countries outside of Africa; 4) studies that did not focus on terrestrial animals; 5) literature reviews or reviews (Burton et al., 2015; Duporge et al., 2020); 6) publications or conference proceedings that were not peer-reviewed or inaccessible; 7) applied behavioural studies which focused on the responses to the presence of camera traps; 8) and qualitative research which did not provide quantitative data (Duporge et al., 2020; Supplementary information Table S2.9).

2.3.5 Statistical analyses

We mainly analysed the data obtained using descriptive statistics, specifically measures of frequencies. We used frequencies and percentages, generated through the use of Microsoft Excel 2013, to show trends.

2.4. Results

2.4.1 Publications

The Web of Science^{TM} generated 628 peer-reviewed journal publications, or conference proceedings, from which 242 publications were excluded from the review as they did not meet the inclusion requirements set. An additional 22 publications were included in the review from the Scopus search string, bringing the total to 408 publications on which this review is focused. The first camera trap study was conducted in Africa in 2005 (Rovero et al., 2005). Since 2005, the number of subsequent publications produced has increased rapidly, particularly in the last decade (Fig. 2.1). In the first five years (2005-2009), 3.4% of camera trapping publications in Africa were conducted, with the following five years (2010-2014) seeing this total rise to 14.7%. The last seven years (2015-2021) exhibited a large increase in publications, with 81.9% of camera trapping publications of the total conducted in Africa during this time.

The majority of camera trap study objectives related to occupancy (169/408, 41.4%), followed by those studies which incorporated multiple objectives into their study (98/408, 24%), with behavioural/ observational studies receiving significant focus as well (88/408, 21.6%; Supplementary information Figure S2.1). Studies focusing on demographics received the least attention (53/408, 13.0%).

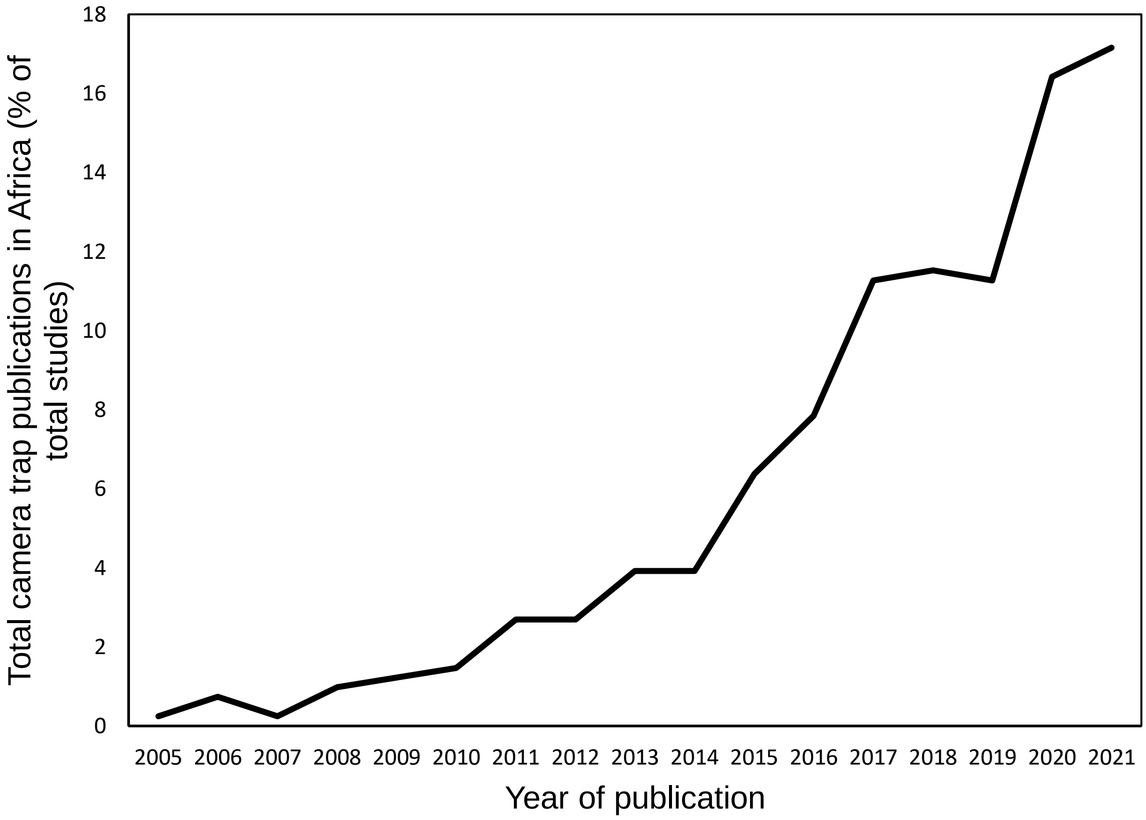

Fig. 2.1. Number of published camera trap studies conducted in Africa between 2005 and 2021 presented as percentages.

2.4.2 Distribution of camera trapping research in Africa

Camera trap studies varied greatly in number across African countries (Fig. 2.2; Supplementary information Tables S2.2 and S2.3) between 2005 and 2021, with several countries displaying considerably higher numbers of camera trap publications than the rest. Out of the 54 African countries, camera trap studies were conducted in 38 (70.4%) countries, with 15 (3.7%) studies occurring across multiple countries, with the remaining 16 countries (29.6%; Supplementary information Table S2.4) having no camera trap studies published. Some of the 408 camera trap publications conducted in Africa reported on more than one country. To determine the percentage contribution made by each African country, we treated each country listed in those publications, with more than one country, as separate. The result brought the total to 429 publications across all the African countries. The majority of camera trap studies in Africa were conducted in South Africa (124/429, 28.9%), followed by Tanzania (51/429, 11.9%) and Namibia (27/429, 6.3%), respectively (Supplementary Information Table 2.2). The number of camera trap studies conducted across African countries was disproportionally high, with the top five countries contributing 250 (58.3%) of the total camera trap studies.

2.4.3 Species focus

Most African camera trap studies focused on a single species (179/408, 43.9%), with community (135/408, 33.1%) and multiple (90/408, 22.1%) species-focused studies being the second and third highest approaches used. Relatively few studies incorporated a combined (4/408, 1.0%) focal species assemblage approach (Supplementary information Tables S2.2 and S2.5). Studies that used camera traps to study communities of animals, especially mammals at a landscape level, were common, with these studies focusing on several species (Supplementary information Table S2.6). Species that were a study's target focus were included in the generated species list (Supplementary information Table S2.5), whilst studies focusing on an overall community of animals were excluded from this list. The numbers of species recorded from these community studies were instead generated in a separate list, which highlighted the number of taxa recorded by the study (Supplementary information Table S2.6).

From the publications reviewed, a total of 209 species received focus, as well as six genera and one family were studied using camera traps (Supplementary information Table S2.5). The terrestrial wildlife species which received the most focus were mainly mammalian; carnivores (46.9%), followed by herbivores (26.9%), primates (12.9%), rodents (2.6%) and domestic mammals (2.0%) (Table 2.1; Supplementary information Table S2.5). The remaining species comprised 3.4% of the studies conducted. Large carnivores (24.8%) received the most focus from the camera trap studies in Africa, followed by small carnivores (15.6%). Several species assemblages, such as amphibians (0.2%), insects (0.3%), reptiles (1.1%) and birds (5.7%), received little attention from the studies conducted. Certain species received particular attention in the species taxa, with publications around large carnivores being focused on leopard (*Panthera pardus*) (60), medium carnivores - serval (*Leptailurus serval*) (13), small carnivores – honey badger (*Mellivora capensis*) (9), large herbivores – African elephant (*Loxodonta africana*) (13), medium herbivores – bushbuck (*Tragelaphus scriptus*) (8), small herbivores – blue duiker (*Philantomba monticola*) (9) and primates – western chimpanzee (*Pan troglodytes verus*) (13). The remaining taxa did not display a focus on a particular species. This was particularly evident for those studies focusing on amphibians (e.g. goliath frog, *Conraua goliath*), birds (e.g. common ostrich, *Struthio camelus*), reptiles (e.g. Nile crocodile, *Crocodylus niloticus*), insects (e.g. African bee, *Apis mellifera*) and rodents (e.g. striped mouse, *Rhabdomys* spp.), which received relatively little research focus.

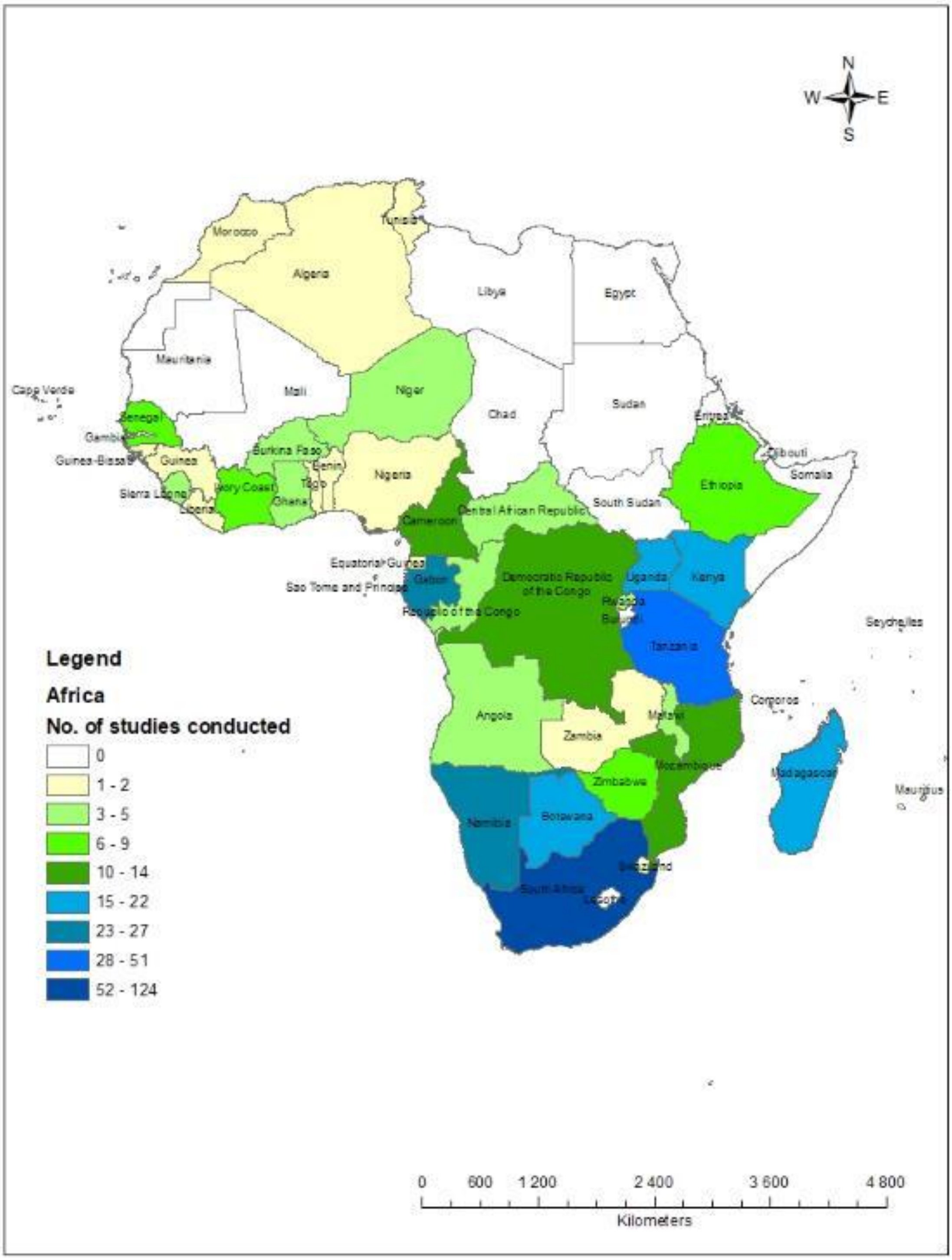

Fig. 2.2. Focus of camera trap studies conducted in African countries.

Table 2.1. Total number of camera trap studies conducted in Africa for each taxon between 2005 and 2021, and also represented as a percentage of the total number of studies. (Note studies focussing on a community of animals were excluded (Supplementary information Table S2.6).

Taxon	Number of studies conducted	Percentage of total camera trap studies in Africa (%)
Insect	2	0.3
Amphibian	1	0.2
Reptilian	7	1.1
Avian	35	5.7
Mammalian		
Domestic	12	2.0
Small omnivore	9	1.5
Rodent	16	2.6
Primate	79	12.9
Small carnivore	96	15.6
Medium carnivore	40	6.5
Large carnivore	152	24.8
Small herbivore	44	7.2
Medium herbivore	44	7.2
Large herbivore	77	12.5

2.4.4 Habitat and land use type

Most camera trap studies conducted in Africa occurred in forests (174/408; 42.6%), with savannah/ bushveld (145/408; 35.5%), grassland (100/408; 24.5%) and woodland (87/408; 21.3%) also receiving considerable focus (Supplementary information Tables S2.6 and S2.7). The remaining habitat types were less common (e.g., sand dunes), with approximately half of the recorded habitat types having less than ten studies conducted in each.

The majority of camera trap studies were conducted in protected areas (281/408, 68.9%), followed by farmland/ community managed land/ concessions/ plantations (47/408, 11.5%) and a combination of farmland and protected areas (42/408, 10.3%; Supplementary Figure S2.2). The remaining land use type combinations (e.g. studies conducted in protected and unprotected areas) received little attention. Most African camera trap research was conducted in areas that were not biodiversity hotspots (247/408, 60.5%), with few studies conducting research in both areas (12/408, 2.9%). The remaining camera trap studies were conducted in biodiversity hotspots (149/408, 36.5%).

2.4.5 Sampling effort

The number of camera trap stations used in the studies conducted in Africa varied considerably, from one to 1 339 camera trap locations, with 13 studies (3.2%) not reporting the exact number of camera trap stations used (e.g. Buschke, 2016; Supplementary information Table S2.2). The total survey length also varied considerably, from 11 h to monitor a goliath frog's nest (Schäfer et al., 2019), to a span of roughly 10 years (Rich et al., 2017a,b), with nine studies (2.2%) not reporting the survey length. Trap effort varied from 11 h to 719 200 camera trap days, with 114 studies (27.9%) not providing the total trap effort. Of the studies which had reported the total trap effort (294 studies), 222 studies (75.5%) reported a total camera trap effort of more than 1 000 camera trap days.

2.4.6 Camera trap types and methods

Most African camera trap studies (371/408, 90.9%) reported the camera trap make or model used (Supplementary information Tables S2.8). From the studies reporting the camera trap make or model used (371 studies), the majority of studies (217/371, 58.5%) used a single camera trap make and model to collect data, with the remaining studies (154/371, 41.5%) incorporating multiple camera trap makes and/or models for data collection.

Most African camera trap studies did not provide information on the type of camera flash used (233/408, 57.1%), with only 175 studies (42.9%) reporting the type of camera trap flash used in the study (Supplementary information Tables S2.8). There was a large disparity between the type of camera flash used among those studies which reported it (Supplementary information Figure S2.3), with most studies (143/175, 81.7%) using the infrared camera flash, followed by xenon/ strobe flash (8/175, 4.6%) and white flash/ white LED/ incandescent flashes (7/175, 4.0%). Film camera flash types made up a small portion (2/175, 1.1%) of studies, with the extra 8.6% resulting from those studies which used multiple camera flashes.

The interval delay used also varied considerably, with the delay between a camera trigger ranging from no delay to a delay of 20 min, with the study using a 20 min delay to assess the foraging and habitat use of common duikers (*Sylvicapra grimmia*) (Abu Baker and Brown, 2013) (Supplementary information Tables S2.8). Many studies did not report the interval delay used for the camera traps deployed (194/408, 47.5%). Of those studies which reported the interval delay used (214 studies), the majority (183/214, 85.5%) used an interval delay of 60 s or less, with studies using an interval delay of more than 60 s (8/214, 3.7%) being significantly less common. Several studies (23/214, 10.7%) incorporated multiple interval delays.

Relatively few studies used, or reported the use, of the camera multishot (306/408, 75.0%) or video (348/408, 85.3%) function, with the studies using the multishot function (102/408, 25.0%) using a multishot ranging from one to 10 images per capture, whilst the studies using the video function (60/408, 14.7%) recorded videos ranging from 5 seconds to being continuous whilst being triggered (Supplementary information Tables S2.8).

From the studies which reported the height of the camera trap placement (246/408, 60.3%, Supplementary information Tables S2.8), the heights ranged considerably from 10 to ~4000 cm. The maximum height that a camera trap was placed (~4000 cm) was in a study assessing the removal and predation of aril-covered seeds on the ground and in the canopy (Evrard et al., 2019). Generally, studies focused on small-medium mammals used a height placement ranging from 10 to 160 cm, while larger mammal studies used a height from ~15 to

400 cm. Camera trap height placement for primates also varied significantly, from ~15 to 900 cm, with arboreal camera traps being pointed towards a trunk or branch (Webber et al., 2020).

Several camera trap data collection methods were used in the research conducted in African countries, with the systematic (171/408, 41.9%) approach being the most frequently used. This approach focuses on placing camera traps at regular intervals, such as grids or transects (Meek et al., 2014). The deliberately biased (142/408, 34.8%) method was the second most frequently used camera trap layout used, which focuses on placing camera traps at specific points of interest, such as waterholes and holes in fences (Meek et al., 2014). Although significantly less than the first two approaches, the random (49/408, 12.0%) layout method was the third-highest approach, which focuses on placing camera traps in a way that would allow a representative sample of the landscape to be achieved, such as covering various habitat types across a landscape (Meek et al., 2014). The remaining layout approaches were less frequently used, which consisted of the non-random (10/408, 2.5%), stratified random (5/408, 1.2%), pseudostratified (2/408, 0.5%) and systematic random (2/408, 0.5%) methods. Few studies incorporated a combined (19/408, 4.7%) layout approach, with some studies not providing (8/408, 2.0%) the layout approach used in their camera trapping survey.

Most African studies did not use baited camera trap stations (365/408, 89.5%), with those studies using baited stations (36/408, 8.8%) focusing on carnivore species. The remaining studies incorporated a combined baiting (7/408, 1.7%) method, whereby only certain stations were baited.

2.5. Discussion

2.5.1 Publications

The number of camera trap studies conducted in Africa displayed a drastic increase a few years after the first camera trap study was conducted in 2005 in Tanzania by Rovero et al. (2005).

This showed a clear indication of how there has been a considerable increase in studies that use camera trapping as a conservation tool to monitor, sample, and conserve animal populations (Rowcliffe and Carbone, 2008; Noss et al., 2012; Galvis et al., 2014). This increase was most notable between 2014 and 2021, which displayed a rapid increase in camera trap publications, with this period being responsible for 85.8% of the total studies conducted. This sudden increase in focus using camera traps may be the result of the increasing need to understand the impacts of severe global changes as a result of anthropogenic activities on biodiversity and functionality of ecosystems, especially if we are to prevent its loss (Pettorelli et al., 2010; Rich et al., 2017b). The increase in the use of camera traps may further be the result of camera traps becoming a more affordable and efficient method for obtaining species abundance and density estimates for animals, particularly over the last few decades, with the non-invasive characteristic of camera traps also allowing them to investigate animal behaviour (Swinnen et al., 2014; Anile and Devillard, 2016; Satterfield et al., 2017).

The focus of camera trap studies on the occupancy of mammals was likely because this resulting knowledge is essential for the conservation of species when considering aspects such as land use intensification (Ramesh and Downs, 2015). The effects environmental disturbances have on species could be determined through occupancy, which can provide information on population status, as mammals are effective indicators of these disturbances (Ramesh and Downs, 2015). The ability to estimate the distribution of species through occupancy analysis allows valuable information to be available for the conservation of wildlife populations (Shannon et al., 2014). This technique may be particularly popular because it is an effective, cost-effective method for many species, which could provide insights into the alterations of species distributions, providing valuable information to conservation practitioners and wildlife managers (Shannon et al., 2014).

Behavioural studies were also popular, likely because of the understanding that knowledge of the behaviours of animals plays an essential role in the implementation of conservation strategies, as the knowledge gained could assist in these efforts (Berger-Tal et al., 2011). Behavioural approaches allow insight into the habitat quality through the animal's perspective, which could determine the environment's status and its potential future suitability (Abu Baker and Brown, 2014).

2.5.2 Distribution of camera trapping research in Africa

Sub-Saharan Africa is highly rich in biodiversity, having several hotspots being home to many endemic and threatened species, making these regions essential for conservation (Blackburn and Measey, 2009), which was reflected by the focus of camera trap research in these areas. Generally, research using camera traps has targeted these species-rich areas, because of their conservation importance, with the vast majority of research focus being directed in South Africa (124, 28.9%). This is likely because the country has several biodiversity rich areas, which includes the Cape Floristic Region, which is one of the most species-rich areas in the world, with roughly 70% of the species found in the region being endemic (Forest et al., 2007; Schnitzler et al., 2011). The Succulent Karoo, occurring along the west coast of South Africa and southern Namibia is also rich in biodiversity (Schnitzler et al., 2011), with areas of the country being characterised by land uses, such as: livestock farming, wildlife ranching, game farms, trophy hunting and eco-tourism (Fabiano et al., 2020). Many of these farmland areas are unfenced, free-movement areas, which creates a conflict between domestic livestock farms and carnivores (Edwards et al., 2015). Namibia received significant camera trap focus (27, 6.3%), with the majority of studies being conducted on farmlands (14/27, 51.9%), with carnivores receiving the most attention (17/27, 63%). The high number of camera trap research studies conducted in Tanzania (51, 11.9%) could also be the result of the region comprising the highest concentration of vertebrates and endemic plant species in the world, occurring specifically along the Eastern Arc Mountains and coastal forests, which extend into Kenya, which also received considerable focus (22, 5.1%) (Blackburn and Measey, 2009). Tanzania may have also received significant focus as it relies heavily on wildlife tourism, which is the second largest contributor of foreign currency in the country, which contributes greatly to economic growth (Pettorelli et al., 2010). Due to the dependency on wildlife for tourism, carnivores play an important role in the country, with conservation being vital in Tanzania, which is home to biodiversity hotspot areas (Pettorelli et al., 2010).

Although not considered a biodiversity hotspot, western and central Africa has a high biodiversity value, with considerable camera trap research being conducted in Gabon (26, 6.1%) (Herrmann et al., 2005). Camera trap research focus decreased in central Africa, with these high biodiversity regions being severely impacted by a lack of formal protected areas, which experience significant habitat destruction (Herrmann et al., 2005). Future research and conservation efforts could possibly be improved in African countries with low research numbers and conserved areas by including the local people and their cultural practices in biodiversity conservation (Adom, 2016). This inclusion has been shown to positively affect biodiversity conservation and social relations, as many cultures have significant knowledge of effective conservation practices in their cultural practices (Adom, 2016). This inclusion has shown significant success in countries such as Tanzania, which have successfully involved traditional practices in conservation efforts (Adom, 2016). These efforts may eventually lead to the need for more research on wildlife monitoring in these areas, as this would assess the effectiveness of the conservation strategies and shape the direction of future management (Ramesh et al., 2016a,b; 2017a,b; Chauvenet et al., 2017).

Generally, countries in Africa which are home to biodiversity hotspots have received significant camera trap research attention; however, this was not always the case. Several species rich countries, some of which (e.g. Ethiopia, Somalia, Liberia and Sierra Leone) received little to no attention from camera trap research. This lack of attention is likely the result of the wars and political unrest experienced in these countries, which often result in the ceasing of conservation efforts because of a lack of available resources despite their high biodiversity value (Herrmann et al., 2005; Hansen et al., 2009). Effective conservation management is relatively costly, with sustained conservation efforts in these countries through national-level funding and international development programs being ineffective as funds disappear with the loss of control by the government (Frazee et al., 2003; Hansen et al., 2009). Despite this, sustained conservation efforts were possible through the support and finances provided by non-governmental organisations (NGOs) (Hansen et al., 2009).

The disparity between camera trap studies conducted across African countries could also be attributed to the human development index (HDI) (Agha et al., 2018). We found that countries with relatively few camera trap studies or no studies conducted generally had lower HDI scores. Due to the natural environments in some countries, particularly the more arid countries, camera trap studies may be less common because of the heat negatively affecting the passive infrared sensor, with the sensors becoming less reliable as the ambient temperature and temperature of the moving animal becoming similar (McCallum, 2013; Meek et al., 2014).

2.5.3 Species focus

The research on terrestrial mammals using camera traps has become increasingly popular as a result of their increased effectiveness and reduced costs (Tobler et al., 2008). We found studies that used camera traps to study communities of animals, especially mammals at a landscape level, to be common (33.1%). This is likely because information is often scarce regarding the trends or statuses of mammalian communities (Ahumada et al., 2011). In habitats such as tropical forests, mammalian communities are rich, with these mammals having a significant role in the ecosystem's functionality (Ahumada et al., 2011; Chiew et al., 2022). It is important to gain an understanding of species distributions if biodiversity loss is to be prevented, with community studies providing the necessary distributional data and information on the factors shaping ecological communities, which could assist management practices, particularly for those communities affected by anthropogenic threats (Ahumada et al., 2011; Cavada et al., 2019). Studies focusing on the mammalian communities are particularly important for effective management practices as applied strategies may affect all species in a landscape (Cavada et al., 2019; Zungu et al., 2020a,b; Sosibo et al., 2022).

We found most camera trap studies in Africa have focused on single species, with increased community studies in recent years. There was a strong use of camera traps for mammalian studies, especially carnivore studies. The strong preference for camera trap studies to be focused on African carnivores is likely the result of the ability of camera traps to monitor rare and elusive species occurring at low densities or with large home ranges non-invasively (Brassine and Parker, 2015; Ferreras et al., 2017; Rich et al., 2017a,b; Van der Weyde et al., 2018), which are often individually identifiable, because of their unique markings (Burton et al., 2015; Anile and Devillard, 2016). Carnivores in Africa are also economically important for many countries that rely on tourism, as they provide numerous benefits, such as wildlife photography and hunting tourism (Pettorelli et al., 2010). This is reinforced by the fact that leopard (60 studies), lion (*Panthera leo*, 24 studies) and spotted hyena (*Crocuta crocuta*, 23 studies) were the primary species of focus. Leopards, in particular, may have received significant focus in camera trap studies because of the ongoing threat habitat destruction has on this species, with their global range being reduced by ~30% (Abade et al., 2018). These threats are expected to result in the further population decline of this species, with their conservation being essential for maintaining ecosystems (Abade et al., 2018; Aebischer et al., 2020). In countries, such as Tanzania, leopard conservation is vital, as the species provides considerable economic gain for the country (Abade et al., 2018). Carnivores, in general, are also of interest in many studies because they are often threatened and influence many species in other trophic levels, with carnivores also being significantly impacted by anthropogenic activities because of the large areas required by these species (McCallum, 2013; Rodríguez-Recio et al., 2022). Although large carnivores had the most focus in terms of the number of studies conducted (152), only eight species of large carnivores were focused on. Although smaller carnivores received significant focus (94 studies), the focus was split among 37 species and one genus. Consequently, no particular species received significant focus, with studies on smaller and medium carnivores often lacking despite their ecological importance and the threatened conservation status of some species (Satterfield et al., 2017).

Camera trap studies rarely focused on species assemblages relating to: Aves, amphibians, reptiles and insects. This lack of research focus is likely because of the availability of more appropriate sampling techniques for these species assemblages, as the use of camera traps has been a popular research tool for those studying rare and cryptic species with unique markings, which are difficult to observe using alternative techniques (O’Brien, 2008; Burton et al., 2015; Dupuis-Desormeaux et al. 2016a; Ferreras et al. 2017). Camera traps may not be the most appropriate tool to study these species assemblages either, as the images obtained are often blurry and of poor photograph quality, which can hinder the ability to accurately identify the species of interest belonging to these assemblages (Dorning and Harris, 2019).

2.5.4 Habitat and land use type

From the studies reporting the habitat type in which camera trap studies were conducted in Africa, the majority were conducted in forests, with savannah/ bushveld also receiving significant attention. The disparity between habitat types covered is significant, with many habitat types receiving little focus. The preference for camera trap studies to be conducted in forests may be because the habitat is visually restrictive and difficult to sample using other observation methods (McCallum, 2013; Ferreras et al., 2018). Camera trapping in forests also allows rare and elusive species to be observed, with direct and aerial observation methods not being a viable option (McCallum, 2013; Ehlers Smith et al., 2018, 2019; Rich et al., 2020; Zungu et al., 2020a,b; Sosibo et al., 2022).

The majority of camera trap studies were conducted in protected areas, such as National Parks, which are responsible for the protection of many species, such as leopards, which are economically important for several African countries, such as Tanzania (Abade et al., 2018). Studies in protected areas seek to provide valuable field data which are lacking for species, such as the leopard, with these studies contributing to the development of effective conservation strategies (Abade et al., 2018). Large carnivores in small enclosed reserves are essential for regulating the natural ecosystem and reducing prey populations (Jooste et al., 2013). To effectively manage carnivores and the carrying capacity of enclosed reserves, knowledge of the population sizes and the dynamics of social groupings is essential for wildlife management and animal ecology (Jooste et al., 2013; Stratford et al., 2020). Land use types outside of protected areas, such as farmland/ rangeland, also received significant camera trap study focus, with several studies being conducted in farmland and protected areas. This is because of the importance of managing surrounding unprotected lands outside of small protected areas, as this is important for the effective conservation of many carnivore species (Kauffman et al., 2007). This is especially true for countries such as Namibia, which comprise 86% unprotected rangelands, which are home to roughly 90% of the populations of several large mammal species, such as cheetah (*Acinonyx jubatus*), which are primarily located outside of protected areas (Kauffman et al., 2007; Schumann et al., 2006). These areas also received significant study focus as there is often a history of human-wildlife conflict, resulting in the decline of wildlife species (Fink et al., 2020). The human-wildlife conflict could result in financial strain for many people and the economy, as wildlife could be responsible for crop destruction and the depredation of livestock (Fink et al., 2020). This conflict can result in the killing of carnivore species, particularly the larger carnivore species, which can hinder conservation efforts (Fink et al., 2020). This was particularly evident in the Masai Mara Nature Reserve, where large carnivores would leave the protected areas to hunt livestock in the surrounding farmlands (Fink et al., 2020).

Most studies were not conducted in biodiversity hotspots; however, these areas did receive significant attention (36.5% of total studies) despite the total area it covers across the African continent. This may be because of the ecological importance of these areas, as loss of biodiversity affects all taxonomic groups, with habitat loss often resulting in the extinction of some species (Jumeau et al., 2017). These areas may be of particular interest to camera trap studies as they can provide biodiversity inventories and conservation assessments (Mann et al., 2015; Rich et al., 2017b).

2.5.5 Sampling effort

Studies which reported high numbers of trapping efforts generally focused on carnivores, likely because some species occur at low densities across large areas, which would greatly reduce the chance of capture; therefore, an extended survey period could improve the chance of capture (Brassine and Parker, 2015). It is apparent in the camera trapping studies conducted in Africa that there is little standardisation of procedures when focusing on particular species assemblages, such as carnivores, with trapping effort and the number of camera trap stations varying considerably. This is most likely because of a difference in the research question posed and resource constraints between studies (Roberts, 2011; Meek et al., 2015), which make complete standardisation between studies impractical. However, considerable variation could be problematic for many species, as an insufficient sampling effort may significantly impact the ability of the survey design to detect rare species (Burton et al., 2015). The lack of standardisation regarding trapping effort, distances between camera traps and size of the area surveyed is a recognised problem for carnivores (Ferreras et al., 2017). It is generally recommended that site-specific camera trap placement be conducted for carnivores, as the probability of detection is highest using this method (Brassine and Parker, 2015), with the camera trap placement used, as well as their spacing and length of deployment, having an impact on the results and inferences made from the data collected in a study (Burton et al., 2015; Ferreras et al., 2017; Rich et al., 2019).

2.5.6 Camera trap types and methods

Most camera trap mammalian studies in Africa were conducted using a single camera trap make and model; however, many studies incorporated several camera trap makes and models into a survey. This could potentially impact the detectability of certain species, as well as the repeatability of the collected results, with camera trap models having different detection zone sizes, battery life, reliability, image quality, waterproofing and trigger speeds (Meek et al., 2014; Burton et al., 2015; Meek et al., 2015). Many studies also failed to report the type of camera flash, the interval delay used, the camera multishot function or the height that the camera trap was placed. Studies which reported these settings had considerable variability in the settings used. Although variability in survey design between studies is to be expected because of differences in research objectives, the specifics of the camera trap used, the settings adopted, and the height placed could have significant impacts on the ability of a study to detect the species of interest (Meek et al., 2015; Burton et al., 2015). This lack of standardisation and reliable protocols is also problematic because of the possibility of studies producing misleading results and preventing the ability of studies to compare results effectively (Meek et al., 2014; Brassine and Parker, 2015). A standardised protocol is particularly important when focusing on specific species, as the method in which the camera traps are deployed may affect the ability of the study design to detect the species of focus (Meek et al., 2014). Through a more standard camera trap protocol, a more reliable and consistent collection of results could become possible (Burton et al., 2015). To achieve this, it is vital that future research provide detailed reports on the sampling procedures used, as well as the technical difficulties faced. This would allow effective comparisons between studies, ensuring the most appropriate procedure is followed, thereby ensuring measures which could negatively influence the ability of the study to detect the species of focus be avoided (Burton et al., 2015; Meek et al., 2015; Newey et al., 2015). The adoption of appropriate sampling procedures to effectively detect wildlife is vital for conservation management, as it requires effective monitoring of biodiversity to learn from the conservation strategies enforced, and to guide future conservation management practices (Lindenmayer et al., 2012).

2.5.7 Conclusions

Through the review of camera trap studies conducted in Africa, it is clear that it has become an increasingly popular method to study various species, with carnivores, particularly large carnivores, receiving significant focus. The focus of camera trap research is disproportionate across African countries, with countries such as South Africa, receiving considerably more focus, with many African countries receiving little attention. This large disparity in research focus could possibly be improved through the inclusion of local people and their traditional practices in biodiversity conservation, which could eventually lead to the need for research to monitor wildlife populations. Countries with biodiversity hotspots generally received more research focus; however, factors such as political instability and conflict severely reduced the studies conducted in several species-rich countries. Despite the conservation struggles experienced in these countries, NGO funding and support showed positive results for maintaining conservation areas. Future trends will hopefully shift to those understudied countries, which often lack conservation areas, as biodiversity estimates could assist in implementing appropriate conservation strategies. There was also a strong preference for studies to be conducted in protected areas, likely because of the need for field data to implement effective conservation strategies, which is vital for the protection of many species, such as leopard. The assessment of camera trap methodologies used in Africa for all species taxa of focus has shown that there is a clear lack of standardisation of camera trapping procedures used. In particular, aspects such as sampling effort, camera trap make and model, interval delay, camera multishot, height of camera trap placement, camera layout and baiting procedures, ranged significantly between studies focusing on the same species. Many studies did not provide a comprehensive report on the camera trap settings and procedures used, which is important as these factors have a significant impact on the ability of the study to detect the species of interest. Future research implementing a standardised camera trap procedure could allow studies to effectively compare results and allow appropriate protocols to be implemented when focusing on specific species, which would ensure the most appropriate method to detect the species is conducted, with these factors allowing for a reliable and consistent collection of data.

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2.7 References

Abade, L., Cusack, J., Moll, R.J., Strampelli, P., Dickman, A.J., Macdonald, D.W., Montgomery, R.A., 2018. Spatial variation in leopard (*Panthera pardus*) site use across a gradient of anthropogenic pressure in Tanzania's Ruaha landscape. PLoS ONE 13, e0204370.

Aben, J., Bocedi, G., Palmer, S.C.F., Pellikka, P., Strubbe, D., Hallmann, C., Travis, J.M.J., Lens, L., Matthysen, E., 2016. The importance of realistic dispersal models in conservation planning: application of a novel modelling platform to evaluate management scenarios in an Afrotropical biodiversity hotspot. Journal of Applied Ecology 53, 1055-1065.

Abu Baker, M.A., Brown, J.S., 2014. Foraging and habitat use of common duikers, *Sylvicapra grimmia*, in a heterogeneous environment within the Soutpansberg, South Africa. African Journal of Ecology 52, 318-327.

Adom, D., 2016. Inclusion of local people and their cultural practices in biodiversity conservation: lessons from successful nations. American Journal of Environmental Protection 4, 67-78.

Aebischer, T., Ibrahim, T., Hickisch, R., Furrer, R.D., Leuenberger, C., Wegmann, D., 2020. Apex predators decline after an influx of pastoralists in former Central African Republic hunting zones. Biological Conservation 241, 108326.

Agha, M., Batter, T., Bolas, E.C., Collins, A.C., Gomes da Rocha, D., Monteza-Moreno, C.M., Preckler-Quisquater, S., Sollmann, R., 2018. A review of wildlife camera trapping trends across Africa. African Journal of Ecology 56, 694-701.

Ahumada, J.A., Silva, C.E., Gajapersad, K., Hallam, C., Hurtado, J., Martin, E., McWilliam, A., Mugerwa, B., O'Brien, T., Rovero, F., Sheil, D., Spironello, W.R., Winarni, N., Andelman, S.J., 2011. Community structure and diversity of tropical forest mammals: data from a global camera trap network. Philosophical Transactions of the Royal Society B: Biological Sciences 366, 2703-2711.

Alexander, J., Ehlers Smith, D.A., Ehlers Smith, Y.C., Downs, C.T., 2019. Eco-estates: diversity hotspots or isolated developments? Connectivity of eco-estates in the Indian Ocean Coastal Belt, KwaZulu-Natal, South Africa. Ecological Indicators 103, 425-433.

Amin, R., Klair, H., Wacher, T., Ndjassi, C., Fowler, A., Olson, D., Bruce, T., 2021a. Estimating forest antelope population densities using distance sampling with camera traps. Oryx 56, 345-351.

Anile, S., Devillard, S., 2016. Study design and body mass influence RAIs from camera trap studies: evidence from the Felidae. Animal Conservation 19, 35-45.

Assou, D., D'Cruze, N., Kirkland, H., Auliya, M., Macdonald, D.W., Segniagbeto, G.H., 2021. Camera trap survey of mammals in the Fazao-Malfakassa National Park, Togo, West Africa. African Journal of Ecology 59, 583-596.

Bach, C.E., Kelly, D., 2004. Effects of forest edges, fruit display size, and fruit colour on bird seed dispersal in a New Zealand mistletoe, *Alepis flavida*. New Zealand Journal of Ecology 28, 93-103.

Batáry, P., Fronczek, S., Normann, C., Scherber, C., Tscharntke, T., 2014. How do edge effect and tree species diversity change bird diversity and avian nest survival in Germany's largest deciduous forest? Forest Ecology and Management 319, 44-50.

Berger-Tal, O., Polak, T., Oron, A., Lubin, Y., Kotler, B.P., Saltz, D., 2011. Integrating animal behavior and conservation biology: a conceptual framework. Behavioral Ecology 22, 236-239.

Bessone, M., Kühl, H.S., Hohmann, G., Herbinger, I., N'Goran, K.P., Asanzi, P., Da Costa, P., Dérozier, V., Fotsing, E.D.B., Beka, B.I., Iyomi, M.D., Iyatshi, I.B., Kafando, P., Kambere, M.A., Moundzoho, D.B., Wanzalire, M.L.K., Fruth, B., 2020. Drawn out of the shadows: surveying secretive forest species with camera trap distance sampling. Journal of Applied Ecology 57, 963-974.

Bissessur, P., Bunsy, Y., Baider, C., Florens, F.B.V., 2019. Non-intrusive systematic study reveals mutualistic interactions between threatened island endemic species and points to more impactful conservation. Journal for Nature Conservation 49, 108-117.

Blackburn, D.C., Measey, G.J., 2009. Dispersal to or from an African biodiversity hotspot? Molecular Ecology 18, 1904-1915.

Brassine, E., Parker, D., 2015. Trapping elusive cats: using intensive camera trapping to estimate the density of a rare African felid. PLoS ONE 10, e0142508.

Bruce, T., Amin, R., Wacher, T., Fankem, O., Ndjassi, C., Ngo Bata, M., Fowler, A., Ndinga, H., Olson, D., 2018. Using camera trap data to characterise terrestrial larger-bodied mammal communities in different management sectors of the Dja Faunal Reserve, Cameroon. African Journal of Ecology 56, 759-776.

Burt, C., Fritz, H., Keith, M., Guerbois, C., Venter, J.A., 2021. Assessing different methods for measuring mammal diversity in two southern African arid ecosystems. Mammal Research 66, 313-326.

Burton, A.C., Neilson, E., Moreira, D., Ladle, A., Steenweg, R., Fisher, J.T., Bayne, E., Boutin, S., 2015. Wildlife camera trapping: a review and recommendations for linking surveys to ecological processes. Journal of Applied Ecology 52, 675-685.

Burton, A.C., Sam, M.K., Balangtaa, C., Brashares, J.S., 2012. Hierarchical multi-species modeling of carnivore responses to hunting, habitat and prey in a West African protected area. PLoS ONE 7, e38007.

Burton, A.C., Sam, M.K., Kpelle, D.G., Balangtaa, C., Buedi, E.B., Brashares, J.S., 2011. Evaluating persistence and its predictors in a West African carnivore community. Biological Conservation 144, 2344-2353.

Buschke, F.T., 2016. A camera trap survey of nocturnal mammals on former farmland in the eastern Free State Province, South Africa, 10 years after removing livestock. African Journal of Ecology 54, 514-518.

Cavada, N., Worsøe Havmøller, R., Scharff, N., Rovero, F., 2019. A landscape-scale assessment of tropical mammals reveals the effects of habitat and anthropogenic disturbance on community occupancy. PLoS ONE 14, e0215682.

Chauvenet, A.L., Gill, R.M., Smith, G.C., Ward, A.I., Massei, G., 2017. Quantifying the bias in density estimated from distance sampling and camera trapping of unmarked individuals. Ecological Modelling 350, 79-86.

Chiew, L.Y., Hackett, T.D., Brodie, J.F., Teoh, S.W., Burslem, D.F.R.P., Reynolds, G., Deere, N.J., Vairappan, C.S., Slade, E.M., 2022. Tropical forest dung beetle–mammal dung interaction networks remain similar across an environmental disturbance gradient. Journal of Animal Ecology 91, 604-617.

Clauss, M., Scriba, M., Kioko, J., Ganzhorn, J.U., Kiffner, C., 2021. Camera-trap data do not indicate scaling of diel activity and cathemerality with body mass in an East African mammal assemblage. Ecology and Evolution 11, 13846-13861.

Colyn, R.B., Campbell, A.M., Smit-Robinson, H.A., 2017. The application of camera trapping to assess Rallidae species richness within palustrine wetland habitat in South Africa. Ostrich 88, 235-245.

Connolly, E., Allan, J., Brehony, P., Aduda, A., Western, G., Russell, S., Dickman, A., Tyrrell, P., 2021. Coexistence in an African pastoral landscape: Evidence that livestock and wildlife temporally partition water resources. African Journal of Ecology 59, 696-711.

Curveira-Santos, G., Sutherland, C., Santos-Reis, M., Swanepoel, L.H., 2021a. Responses of carnivore assemblages to decentralized conservation approaches in a South African landscape. Journal of Applied Ecology 58, 92-103.

Curveira-Santos, G., Sutherland, C., Tenan, S., Fernández-Chacón, A., Mann, G.K., Pitman, R.T., Swanepoel, L.H., 2021b. Mesocarnivore community structuring in the presence of Africa's apex predator. Proceedings of the Royal Society B 288, 20202379.

Cusack, J.J., Dickman, A.J., Rowcliffe, J.M., Carbone, C., Macdonald, D.W., Coulson, T., 2015. Random versus game trail-based camera trap placement strategy for monitoring terrestrial mammal communities. PLoS ONE 10, e0126373.

Dorning, J., Harris, S., 2019. The challenges of recognising individuals with few distinguishing features: Identifying red foxes *Vulpes vulpes* from camera-trap photos. PLoS ONE 14, e0216531.

dos Anjos, L., Collins, C.D., Holt, R.D., Volpato, G.H., Mendonça, L.B., Lopes, E.V., Boçon, R., Bisheimer, M.V., Serafini, P.P., Carvalho, J., 2011. Bird species abundance–occupancy patterns and sensitivity to forest fragmentation: implications for conservation in the Brazilian Atlantic forest. Biological Conservation 144, 2213-2222.

Drouilly, M., Clark, A., O'Riain, M.J., 2018. Multi-species occupancy modelling of mammal and ground bird communities in rangeland in the Karoo: a case for dryland systems globally. Biological Conservation 224, 16-25.

Drouilly, M., O'Riain, M.J., 2019. Wildlife winners and losers of extensive small-livestock farming: a case study in the South African Karoo. Biodiversity and Conservation 28, 1493-1511.

Duporge, I., Hodgetts, T., Wang, T., Macdonald, D.W., 2020. The spatial distribution of illegal hunting of terrestrial mammals in Sub-Saharan Africa: a systematic map. Environmental Evidence 9, 1-14.

Dupuis-Désormeaux, M., Davidson, Z., Mwololo, M., Kisio, E., Taylor, S., MacDonald, S.E., 2015. Testing the prey-trap hypothesis at two wildlife conservancies in Kenya. PLoS ONE 10, e0139537.

Dupuis-Désormeaux, M., Davidson, Z., Mwololo, M., Kisio, E., MacDonald, S.E., 2016a. Comparing motion capture cameras versus human observer monitoring of mammal movement through fence gaps: a case study from Kenya. African Journal of Ecology 54, 154-161.

Dupuis-Désormeaux, M., Davidson, Z., Mwololo, M., Kisio, E., MacDonald, S.E., 2016b. Usage of specialized fence-gaps in a black rhinoceros conservancy in Kenya. African Journal of Wildlife Research 46, 22-32.

Dupuis-Désormeaux, M., Kaaria, T.N., Mwololo, M., Davidson, Z., MacDonald, S.E., 2018. A ghost fence-gap: surprising wildlife usage of an obsolete fence crossing. PeerJ 6, e5950.

Easter, T., Bouley, P., Carter, N., 2019. Opportunities for biodiversity conservation outside of Gorongosa National Park, Mozambique: a multispecies approach. Biological Conservation 232, 217-227.

Edwards, S., Gange, A.C., Wiesel, I., 2015. Spatiotemporal resource partitioning of water sources by African carnivores on Namibian commercial farmlands. Journal of Zoology 297, 22-31.

Ehlers Smith, Y., Ehlers Smith, D., Ramesh, T., Downs, C.T. 2017. The importance of microhabitat structure in maintaining forest mammal diversity in a mixed land-use mosaic. Biodiversity and Conservation 26, 2361-2382.

Ehlers Smith, Y., Ehlers Smith, D., Ramesh, T., Downs, C.T. 2018. Forest habitats in a mixed urban-agriculture mosaic landscape: patterns of mammal occupancy. Landscape Ecology 33, 59-76.

Ehlers Smith, Y., Ehlers Smith, D., Ramesh, T., Downs, C.T. 2019. Novel predators and anthropogenic disturbance influence spatio-temporal distribution of forest antelope species. Behavioural Processes 159, 9-22.

Ehlers Smith, Y., Ehlers Smith, D., Ramesh, T., Downs, C.T. 2020. Co-occurrence modelling highlights negative conservation implications for two competing spiral-horned antelope. Austral Ecology 45, 305–318.

Etana, B., Atickem, A., Tsegaye, D., Bekele, A., De Beenhouwer, M., Hundera, K., Lens, L., Fashing, P.J., Stenseth, N.C., 2021. Traditional shade coffee forest systems act as refuges for medium-and large-sized mammals as natural forest dwindles in Ethiopia. Biological Conservation 260, 109219.

Evrard, Q., Hardy, O.J., Tagg, N., Doucet, J.L., 2019. Removal and predation of aril-covered seeds: the case of *Afzelia bipindensis* (Fabaceae–Detarioidae). Plant Ecology and Evolution 152, 460-469.

Fabiano, E.C., Sutherland, C., Fuller, A.K., Nghikembua, M., Eizirik, E., Marker, L., 2020. Trends in cheetah *Acinonyx jubatus* density in north-central Namibia. Population Ecology 62, 233-243

Farris, Z.J., Kelly, M.J., Karpanty, S., Murphy, A., Ratelolahy, F., Andrianjakarivelo, V., Holmes, C., 2017. The times they are a changin': Multi-year surveys reveal exotics replace native carnivores at a Madagascar rainforest site. Biological Conservation 206, 320-328.

Ferreras, P., Díaz-Ruiz, F., Alves, P.C., Monterroso, P., 2017. Optimizing camera-trapping protocols for characterizing mesocarnivore communities in south-western Europe. Journal of Zoology 301, 23-31.

Ferreras, P., Díaz-Ruiz, F., Monterroso, P., 2018. Improving mesocarnivore detectability with lures in camera-trapping studies. Wildlife Research 45, 505-517.

Fink, S., Chandler, R., Chamberlain, M., Castleberry, S., Glosenger-Thrasher, S., 2020. Distribution and activity patterns of large carnivores and their implications for human–carnivore conflict management in Namibia. Human–Wildlife Interactions 14, 287-295.

Fonteyn, D., Vermeulen, C., Deflandre, N., Cornelis, D., Lhoest, S., Houngbégnon, F.G.A., Doucet, J.L., Fayolle, A., 2021. Wildlife trail or systematic? Camera trap placement has little effect on estimates of mammal diversity in a tropical forest in Gabon. Remote Sensing in Ecology and Conservation 7, 321-336.

Forest, F., Grenyer, R., Rouget, M., Davies, T.J., Cowling, R.M., Faith, D.P., Balmford, A., Manning, J.C., Proches, S., van der Bank, M., Reeves, G., Hedderson, T.A.J., Savolainen, V., 2007. Preserving the evolutionary potential of floras in biodiversity hotspots. Nature 445, 757-760.

Frazee, S.R., Cowling, R.M., Pressey, R.L., Turpie, J.K., Lindenberg, N., 2003. Estimating the costs of conserving a biodiversity hotspot: a case-study of the Cape Floristic Region, South Africa. Biological Conservation 112, 275-290.

Fuda, R.K., Ryan, S.J., Cohen, J.B., Hartter, J., Frair, J.L., 2018. Assessing the impacts of oil exploration and restoration on mammals in Murchison Falls Conservation Area, Uganda. African Journal of Ecology 56, 804-817.

Galvis, N., Link, A., Di Fiore, A., 2014. A novel use of camera traps to study demography and life history in wild animals: a case study of spider monkeys (*Ateles belzebuth*). International Journal of Primatology 35, 908-918.

Gaugris, J., Niemand, L., Thomas, A., Orban, B., Morley, R., Melville, H., Drescher, K., Gaugris, C.A.V., 2021. A snapshot camera trap assessment of mammals in Congo's Massif du Chaillu with a noteworthy record of grey-necked rockfowl *Picathartes oreas*. African Journal of Ecology 59, 749-754.

Gaynor, K.M., Daskin, J.H., Rich, L.N., Brashares, J.S., 2021. Postwar wildlife recovery in an African savanna: evaluating patterns and drivers of species occupancy and richness. Animal Conservation 24, 510-522.

Gebert, F., Njovu, H.K., Treydte, A.C., Steffan-Dewenter, I., Peters, M.K., 2019. Primary productivity and habitat protection predict elevational species richness and community biomass of large mammals on Mt. Kilimanjaro. Journal of Animal Ecology 88, 1860-1872.

Gebert, F., Steffan-Dewenter, I., Moretto, P., Peters, M.K., 2020. Climate rather than dung resources predict dung beetle abundance and diversity along elevational and land use gradients on Mt. Kilimanjaro. Journal of Biogeography 47, 371-381.

Gerber, B., Karpanty, S.M., Crawford, C., Kotschwar, M., Randrianantenaina, J., 2010. An assessment of carnivore relative abundance and density in the eastern rainforests of Madagascar using remotely-triggered camera traps. Oryx 44, 219-222.

Gerber, B.D., Karpanty, S.M., Randrianantenaina, J., 2012. The impact of forest logging and fragmentation on carnivore species composition, density and occupancy in Madagascar's rainforests. Oryx 46, 414-422.

Gessner, J., Buchwald, R., Wittemyer, G., 2014. Assessing species occurrence and species-specific use patterns of bais (forest clearings) in Central Africa with camera traps. African Journal of Ecology 52, 59-68.

Greco, I., Chizzola, M., Meloro, C., Swanepoel, L., Tamagnini, D., Dalerum, F., 2021. Similarities between lions and sympatric carnivores in diel activity, size and morphology. Hystrix, the Italian Journal of Mammalogy 32, 122-129.

Gil-Sánchez, J.M., Mañá-Varela, B., Herrera-Sánchez, F.J., Urios, V., 2021. Spatio-temporal ecology of a carnivore community in middle Atlas, NW of Morocco. Zoology 146, 125904.

Habel, J.C., Rasche, L., Schneider, U.A., Engler, J.O., Schmid, E., Rödder, D., Meyer, S.T., Trapp, N., del Diego, R.S., Eggermont, H., Lens, L., Stork, N.E., 2019. Final countdown for biodiversity hotspots. Conservation Letters 12, e12668.

Hanekom, N., Randall, R.M., 2015. Assessments of occurrence and distribution of mammals in forests of the Garden Route National Park based on camera trapping. Koedoe 57, 1257.

Hanson, T., Brooks, T.M., Da Fonseca, G.A., Hoffmann, M., Lamoreux, J.F., Machlis, G., Mittermeier, C.G., Mittermeier, R.A., Pilgrim, J.D., 2009. Warfare in biodiversity hotspots. Conservation Biology 23, 578-587.

Haurez, B., Daïnou, K., Tagg, N., Petre, C.A., Doucet, J.L., 2015. The role of great apes in seed dispersal of the tropical forest tree species Dacryodes normandii (Burseraceae) in Gabon. Journal of Tropical Ecology 31, 395-402.

Hausser, Y., Tagand, R., Vimercati, E., Mermod, S., Fischer, C., 2017. Comparing survey methods to assess the conservation value of a community-managed protected area in western Tanzania. African Journal of Ecology 55, 1-11.

Hayward, M.W., Hayward, M.D., 2012. Waterhole use by African fauna. African Journal of Wildlife Research 42, 117-127.

Hedwig, D., Kienast, I., Bonnet, M., Curran, B.K., Courage, A., Boesch, C., Kuhl, H.S., King, T., 2018. A camera trap assessment of the forest mammal community within the transitional savannah-forest mosaic of the Batéké Plateau National Park, Gabon. African Journal of Ecology 56, 777-790.

Hegerl, C., Burgess, N.D., Nielsen, M.R., Martin, E., Ciolli, M., Rovero, F., 2017. Using camera trap data to assess the impact of bushmeat hunting on forest mammals in Tanzania. Oryx 51, 87-97.

Herrmann, H., Bohme, W., Herrmann, P.A., Plath, M., Schmitz, A., Solbach, M., 2005. African biodiversity hotspots: the amphibians of Mt. Nlonako, Cameroon. Salamandra 41, 61-81.

Janecke, B.B., 2021. Mammal species richness at a catena and nearby waterholes during a drought, Kruger National Park, South Africa. Diversity 13, 387.

Johnson, S.D., Van der Niet, T., 2019. Bird pollination in an African Satyrium (Orchidaceae) confirmed by camera traps and selective exclusion experiments. Plant Systematics and Evolution 305, 477-484.

Jooste, E., Hayward, M.W., Pitman, R.T., Swanepoel, L.H., 2013. Effect of prey mass and selection on predator carrying capacity estimates. European Journal of Wildlife Research 59, 487-494.

Jumeau, J., Petrod, L., Handrich, Y., 2017. A comparison of camera trap and permanent recording video camera efficiency in wildlife underpasses. Ecology and Evolution 7, 7399-7407.

Kauffman, M.J., Sanjayan, M., Lowenstein, J., Nelson, A., Jeo, R.M., Crooks, K.R., 2007. Remote camera-trap methods and analyses reveal impacts of rangeland management on Namibian carnivore communities. Oryx 41, 70-78.

Kavwele, C.M., Kimanzi, J.K., Kinyanjui, M.J., 2017. Impacts of bush encroachment on wildlife species diversity, composition, and habitat preference in Ol Pejeta Conservancy, Laikipia, Kenya. International Journal of Ecology 2017, 5620125.

Kiepiel, I., Johnson, S.D., 2019. Spit it out: Monkeys disperse the unorthodox and toxic seeds of *Clivia miniata* (Amaryllidaceae). Biotropica 51, 619-625.

Kinnaird, M.F., O'Brien, T.G., 2012. Effects of private-land use, livestock management, and human tolerance on diversity, distribution, and abundance of large African mammals. Conservation Biology 26, 1026-1039.

Klopper, R.R., Smith, G.F., Van Rooy, J., 2002. The biodiversity of Africa. Rebirth of Science in Africa: A Shared Vision for Life and Environmental Sciences, 60-86.

Kühn, N., Midgley, J., Steenhuisen, S.L., 2017. Reproductive biology of three co-occurring, primarily small-mammal pollinated Protea species (Proteaceae). South African Journal of Botany 113, 337-345.

Lhoest, S., Fonteyn, D., Daïnou, K., Delbeke, L., Doucet, J. L., Dufrêne, M., Josso, J.F., Ligot, G., Oszwald, J., Rivault, E., Verheggen, F., Vermeulen, C., Biwolé, A., Fayolle, A., 2020. Conservation value of tropical forests: Distance to human settlements matters more than management in Central Africa. Biological Conservation 241, 108351.

Lindenmayer, D.B., Gibbons, P., Bourke, M.A.X., Burgman, M., Dickman, C.R., Ferrier, S., Fitzsimons, J., Freudenberger, D., Garnett, S.T., Groves, C., Hobbs, R.J., Kingsford, R.T., Krebs, C., Legge, S., Lowe, A.J., McLean, R., Montambault, J., Possingham, H., Radford, J., Robinson, D., Smallbone, L., Thomas, D., Varcoe, T., Vardon, M., Wardle, G., Woinarski, J., Zerger, A., 2012. Improving biodiversity monitoring. Austral Ecology 37, 285-294.

Lombardi, G.C., Peter, C.I., Turner, R.C., Midgley, J.J., 2017. The unusual, closed flowers of *Erica lanuginosa* (Ericaceae) are adapted for rodent-pollination and not cleistogamy. South African Journal of Botany 111, 189-193.

Mann, G.K., O'Riain, M.J., Parker, D.M., 2015. The road less travelled: assessing variation in mammal detection probabilities with camera traps in a semi-arid biodiversity hotspot. Biodiversity and Conservation 24, 531-545.

Mann, G.K., Wilkinson, A., Hayward, J., Drouilly, M., O'Riain, M.J., Parker, D.M., 2019. The effects of aridity on land use, biodiversity and dietary breadth in leopards. Mammalian Biology 98, 43-51.

Marrocoli, S., Nielsen, M.R., Morgan, D., van Loon, T., Kulik, L., Kühl, H., 2019. Using wildlife indicators to facilitate wildlife monitoring in hunter-self monitoring schemes. Ecological Indicators 105, 254-263.

Martin, E.H., Cavada, N., Ndibalema, V.G., Rovero, F., 2015. Modelling fine-scale habitat associations of medium-to-large forest mammals in the Udzungwa Mountains of Tanzania using camera trapping. Tropical Zoology 28, 137-151.

Martin, E.H., Ndibalema, V.G., Rovero, F., 2017. Does variation between dry and wet seasons affect tropical forest mammals' occupancy and detectability by camera traps? Case study from the Udzungwa Mountains, Tanzania. African Journal of Ecology 55, 37-46.

Mateo-Tomás, P., Olea, P.P., Moleón, M., Selva, N., Sánchez-Zapata, J.A., 2017. Both rare and common species support ecosystem services in scavenger communities. Global Ecology and Biogeography 26, 1459-1470.

Mayengo, G., Armbruster, W., Treydte, A.C., 2020. Quantifying nutrient re-distribution from nutrient hotspots using camera traps, indirect observation and stable isotopes in a Miombo ecosystem, Tanzania. Global Ecology and Conservation 23, e01073.

McCallum, J., 2013. Changing use of camera traps in mammalian field research: habitats, taxa and study types. Mammal Review 43, 196-206.

McCollum, K.R., Belinfonte, E., Conway, A.L., Carroll, J.P., 2018. Occupancy and habitat use by six species of forest ungulates on Tiwai Island, Sierra Leone. Koedoe 60, 1-5.

Meek, P.D., Ballard, G.A., Fleming, P.J., 2015. The pitfalls of wildlife camera trapping as a survey tool in Australia. Australian Mammalogy 37, 13-22.

Meek, P.D., Ballard, G., Claridge, A., Kays, R., Moseby, K., O’Brien, T., O’Connell, A., Sanderson, J., Swann, D.E., Tobler, M., Townsend, S., 2014. Recommended guiding principles for reporting on camera trapping research. Biodiversity and Conservation 23, 2321-2343.

Mertens, J.E.J., Emsens, W.J., Jocqué, M., Geeraert, L., De Beenhouwer, M., 2020. From natural forest to coffee agroforest: implications for communities of large mammals in the Ethiopian highlands. Oryx 54, 715-722.

Mills, K.L., Harris, N.C., 2020. Humans disrupt access to prey for large African carnivores. Elife 9, e60690.

Mokotjomela, T.M., Hoffmann, J.H., 2013. Removal of post-dispersed seeds in Acacia cyclops thickets under biological control in South Africa. South African Journal of Botany 88, 260-264.

Moore, J.F., Pine, W.E., Mulindahabi, F., Niyigaba, P., Gatorano, G., Masozera, M.K., Beaudrot, L., 2020. Comparison of species richness and detection between line transects, ground camera traps, and arboreal camera traps. Animal Conservation 23, 561-572.

Moupela, C., Doucet, J.L., Daïnou, K., Tagg, N., Bourland, N., Vermeulen, C., 2014. Dispersal and predation of diaspores of Coula edulis Baill. in an evergreen forest of Gabon. African Journal of Ecology 52, 88-96.

Msuha, M.J., Carbone, C., Pettorelli, N., Durant, S.M., 2012. Conserving biodiversity in a changing world: land use change and species richness in northern Tanzania. Biodiversity and Conservation 21, 2747-2759.

Mugerwa, B., Sheil, D., Ssekiranda, P., van Heist, M., Ezuma, P., 2013. A camera trap assessment of terrestrial vertebrates in Bwindi Impenetrable National Park, Uganda. African Journal of Ecology 51, 21-31.

Murphy, A.J., Farris, Z.J., Karpanty, S., Kelly, M.J., Miles, K.A., Ratelolahy, F., Rahariniaina, R.P., Golden, C.D., 2018. Using camera traps to examine distribution and occupancy trends of ground-dwelling rainforest birds in north-eastern Madagascar. Bird Conservation International 28, 567-580.

Nakashima, Y., 2015. Inventorying medium-and large-sized mammals in the African lowland rainforest using camera trapping. Tropics 23, 151-164.

Newey, S., Davidson, P., Nazir, S., Fairhurst, G., Verdicchio, F., Irvine, R.J., van der Wal, R., 2015. Limitations of recreational camera traps for wildlife management and conservation research: A practitioner's perspective. Ambio 44, 624-635.

Nghikembua, M.T., Marker, L.L., Brewer, B., Mehtätalo, L., Appiah, M., Pappinen, A., 2020. Response of wildlife to bush thinning on the north central freehold farmlands of Namibia. Forest Ecology and Management 473, 118330.

Niang, A., Ndiaye, P.I., 2021. A large mammal survey in Koyli Alpha Community Wildlife Reserve and its surroundings in the Great Green Wall extension area in Senegal. Journal of Threatened Taxa 13, 19223-19231.

Noss, A.J., Gardner, B., Maffei, L., Cuéllar, E., Montaño, R., Romero-Muñoz, A., Sollman, R., O'Connell, A.F., 2012. Comparison of density estimation methods for mammal populations with camera traps in the Kaa-Iya del Gran Chaco landscape. Animal Conservation 15, 527-535.

Nyiramana, A., Mendoza, I., Kaplin, B.A., Forget, P.M., 2011. Evidence for seed dispersal by rodents in tropical montane forest in Africa. Biotropica 43, 654-657.

Oberosler, V., Tenan, S., Zipkin, E.F., Rovero, F., 2020. Poor management in protected areas is associated with lowered tropical mammal diversity. Animal Conservation 23, 171-181.

O'Brien, T.G., 2008. On the use of automated cameras to estimate species richness for large- and medium-sized rainforest mammals. Animal Conservation 11, 179-181.

Omeja, P.A., Lawes, M.J., Corriveau, A., Valenta, K., Sarkar, D., Paim, F. P., Chapman, C.A., 2016. Recovery of tree and mammal communities during large-scale forest regeneration in Kibale National Park, Uganda. Biotropica 48, 770-779.

Orban, B., Kabafouako, G., Morley, R., Vasicek Gaugris, C., Melville, H., Gaugris, J., 2018. Common mammal species inventory utilizing camera trapping in the forests of Kouilou Département, Republic of Congo. African Journal of Ecology 56, 750-754.

Page-Nicholson, S.K., Tate, G., Hoogstad, C., Murison, M., Diamond, M., Blofield, A., Pretorius, M., Michael, M.D., 2018. Mitigating the impact of large mammals on wooden electrical distribution poles in the Kruger National Park, South Africa. African Journal of Wildlife Research 48, 023006.

Patterson, L., Kalle, R., Downs, C., 2016. Predation of artificial bird nests in suburban gardens of KwaZulu-Natal, South Africa. Urban Ecosystems 19, 615-630.

Payne, S.L., Witkowski, E.T., Symes, C.T., 2019. Good times, bad times: inter-annual reproductive output in a montane endemic succulent (*Aloe peglerae*; Asphodelaceae) driven by contrasting visitor responses of small mammals and birds. Australian Journal of Botany 67, 116-127.

Pettorelli, N., Lobora, A.L., Msuha, M.J., Foley, C., Durant, S.M., 2010. Carnivore biodiversity in Tanzania: revealing the distribution patterns of secretive mammals using camera traps. Animal Conservation 13, 131-139.

Ramesh, T., Downs, C.T., 2015. Impact of land use on occupancy and abundance of terrestrial mammals in the Drakensberg Midlands, South Africa. Journal for Nature Conservation 23, 9-18.

Ramesh, T., Kalle, R., Rosenlund, H., Downs, C.T. 2016a. Native habitat and Protected Area size matters: Preserving mammalian assemblages in the Maputaland Conservation Unit of South Africa. Forest Ecology and Management 360, 20-29. https://doi.org/10.1016/j.foreco.2015.10.005

Ramesh, T., Kalle, R., Downs, C.T. 2016b. Predictors of mammal species richness in KwaZulu-Natal, South Africa. Ecological Indicators 60, 385-393. https://doi.org/10.1016/j.ecolind.2015.07.011

Rasambainarivo, F., Farris, Z.J., Andrianalizah, H., Parker, P.G., 2017. Interactions between carnivores in Madagascar and the risk of disease transmission. EcoHealth 14, 691-703.

Razafindratsima, O.H., 2017. Post-dispersal seed removal by rodents in Ranomafana rain forest, Madagascar. Journal of Tropical Ecology 33, 232.

Reece, S.J., Radloff, F.G., Leslie, A.J., Amin, R., Tambling, C.J., 2021. A camera trap appraisal of species richness and community composition of medium and large mammals in a Miombo woodland reserve. African Journal of Ecology 59, 898-911.

Rich, A.M., Poindexter, S.A., Lai, A., Steiniche, T.B., Mutegeki, R., Wasserman, M.D., 2020. A camera trap survey in a protected forest with potential for landscape connectivity across Western Uganda. African Journal of Ecology 58, 529-533.

Rich, L.N., Davis, C.L., Farris, Z.J., Miller, D.A., Tucker, J.M., Hamel, S., Farhadinia, M.S., Steenweg, R., Di Bitetti, M.S., Thapa, K., Kane, M.D., Sunarto, S., Robinson, N.P., Paviolo, A., Cruz, P., Martins, Q., Gholikhani, N., Taktehrani, A., Whittington, J., Widodo, F.A., Yoccoz, N.G., Wultsch, C., Harmsen, B.J., Kelly, M.J., 2017b. Assessing global patterns in mammalian carnivore occupancy and richness by integrating local camera trap surveys. Global Ecology and Biogeography 26, 918-929.

Rich, L.N., Miller, D.A., Muñoz, D.J., Robinson, H.S., McNutt, J. W., Kelly, M.J., 2019. Sampling design and analytical advances allow for simultaneous density estimation of seven sympatric carnivore species from camera trap data. Biological Conservation 233, 12-20.

Rich, L.N., Miller, D.A., Robinson, H.S., McNutt, J.W., Kelly, M.J., 2016. Using camera trapping and hierarchical occupancy modelling to evaluate the spatial ecology of an African mammal community. Journal of Applied Ecology 53, 1225-1235.

Rich, L.N., Miller, D.A.W., Robinson, H.S., McNutt, J.W., Kelly, M.J., 2017a. Carnivore distributions in Botswana are shaped by resource availability and intraguild species. Journal of Zoology 303, 90-98.

Roberts, N.J., 2011. Investigation into survey techniques of large mammals: surveyor competence and camera-trapping vs. transect-sampling. Bioscience Horizons 4, 40-49.

Rodrigues, P., Dorresteijn, I., Guilherme, J.L., Hanspach, J., De Beenhouwer, M., Hylander, K., Bekele, B., Senbeta, F., Fischer, J., Nimmo, D., 2021. Predicting the impacts of human population growth on forest mammals in the highlands of southwestern Ethiopia. Biological Conservation 256, 109046.

Rodríguez-Recio, M., Burgos, T., Krofel, M., Lozano, J., Moleón, M., Virgós, E., 2022. Estimating global determinants of leopard home range size in a changing world. Animal Conservation. https://doi.org/10.1111/acv.12777.

Ross, P.H., Patel, E., Ferguson, B., Ravelijaona, R.N., Raoloniana, G.I., Wampole, E., Gerber, B.D., Farris, Z.J., 2020. Assessment of the threatened carnivore community in the recently expanded rainforest protected area Anjanaharibe-Sud Special Reserve, Madagascar. Endangered Species Research 43, 89-98.

Rottstock, T., Göttert, T., Zeller, U., 2020. Relatively undisturbed African savannas-an important reference for assessing wildlife responses to livestock grazing systems in European rangelands. Global Ecology and Conservation 23, e01124.

Rovero, F., Jones, T., Sanderson, J., 2005. Notes on Abbott's duiker (*Cephalophus spadix* True 1890) and other forest antelopes of Mwanihana Forest, Udzungwa Mountains, Tanzania, as revealed by camera-trapping and direct observations. Tropical Zoology 18, 13-23.

Rovero, F., Martin, E., Rosa, M., Ahumada, J.A., Spitale, D., 2014. Estimating species richness and modelling habitat preferences of tropical forest mammals from camera trap data. PLoS ONE 9, e103300.

Rovero, F., Owen, N., Jones, T., Canteri, E., Iemma, A., Tattoni, C., 2017. Camera trapping surveys of forest mammal communities in the Eastern Arc Mountains reveal generalized habitat and human disturbance responses. Biodiversity and Conservation 26, 1103-1119.

Rowcliffe, J.M., Carbone, C., 2008. Surveys using camera traps: are we looking to a brighter future? Animal Conservation 11, 185-186.

Satterfield, L.C., Thompson, J.J., Snyman, A., Candelario, L., Rode, B., Carroll, J.P., 2017. Estimating occurrence and detectability of a carnivore community in eastern Botswana using baited camera traps. African Journal of Wildlife Research 47, 32-46.

Schäfer, M., Tsekané, S.J., Tchassem, F.A.M., Drakulić, S., Kameni, M., Gonwouo, N.L., Rödel, M.O., 2019. Goliath frogs build nests for spawning–the reason for their gigantism? Journal of Natural History 53, 1263-1276.

Schnitzler, J., Barraclough, T.G., Boatwright, J.S., Goldblatt, P., Manning, J.C., Powell, M.P., Rebelo, T., Savolainen, V., 2011. Causes of plant diversification in the Cape biodiversity hotspot of South Africa. Systematic Biology 60, 343-357.

Schumann, M., Schumann, B., Dickman, A., Watson, L.H., Marker, L., 2006. Assessing the use of swing gates in game fences as a potential non-lethal predator exclusion technique. South African Journal of Wildlife Research 36, 173-181.

Seufert, V., Linden, B., Fischer, F., 2010. Revealing secondary seed removers: results from camera trapping. African Journal of Ecology 48, 914-922.

Shannon, G., Lewis, J.S., Gerber, B.D., 2014. Recommended survey designs for occupancy modelling using motion-activated cameras: insights from empirical wildlife data. PeerJ 2, e532.

Simon, I., Che, J., Baker, L.R., 2020. University campuses can contribute to wildlife conservation in urbanizing regions: a case study from Nigeria. Journal of Threatened Taxa 12, 16736-16741.

Soiret, S.P.K., Kouakou, C.Y., Koffi, B.C., Kadjo, B., Kouassi, P., Gomez, P.J., Goodwin, R.M., Kone, I., 2019. The diversity and conservation of mammals in the Dodo Coastal Forest in southwestern Côte d'Ivoire, western Africa: a preliminary study. Journal of Threatened Taxa 11, 13654-13666.

Sosibo, M., Ehlers Smith, D.A., Ehlers Smith, Y.C., Gumede, S.T., Ngcobo, S., Downs, C.T. 2022. Mammalian assemblages in Southern Mistbelt Forests of the northern Eastern Cape, and southern KwaZulu-Natal Provinces, South Africa, and their response to bordering land-use. Mammalian Biology 102:429–440.

Soto-Shoender, J.R., McCleery, R.A., Monadjem, A., Gwinn, D.C., 2018. The importance of grass cover for mammalian diversity and habitat associations in a bush encroached savanna. Biological Conservation 221, 127-136.

Ssali, F., Moe, S.R., Sheil, D., 2018. Tree seed rain and seed removal, but not the seed bank, impede forest recovery in bracken (Pteridium aquilinum (L.) Kuhn)-dominated clearings in the African highlands. Ecology and Evolution 8, 4224-4236.

Ssali, F., Sheil, D., 2019. Some initial observations concerning the African wild banana Ensete ventricosum as a resource for vertebrates. Tropical Conservation Science 12, 1940082919879318.

Stein, A.B., Fuller, T.K., Marker, L.L., 2008. Opportunistic use of camera traps to assess habitat-specific mammal and bird diversity in northcentral Namibia. Biodiversity and Conservation 17, 3579-3587.

Steinbeiser, C.M., Kioko, J., Maresi, A., Kaitilia, R., Kiffner, C., 2019. Relative abundance and activity patterns explain method-related differences in mammalian species richness estimates. Journal of Mammalogy 100, 192-201.

Stommel, C., Hofer, H., Grobbel, M., East, M.L., 2016. Large mammals in Ruaha National Park, Tanzania, dig for water when water stops flowing and water bacterial load increases. Mammalian Biology 81, 21-30.

Stratford, K., Stratford, S., Périquet, S., 2020. Dyadic associations reveal clan size and social network structure in the fission–fusion society of spotted hyaenas. African Journal of Ecology 58, 182-192.

Sutherland, K., Ndlovu, M., Pérez-Rodríguez, A., 2018. Use of artificial waterholes by animals in the southern region of the Kruger National Park, South Africa. African Journal of Wildlife Research 48, 023003.

Swanson, A., Kosmala, M., Lintott, C., Simpson, R., Smith, A., Packer, C., 2015. Snapshot Serengeti, high-frequency annotated camera trap images of 40 mammalian species in an African savanna. Scientific Data 2, 150026.

Swinnen, K.R., Reijniers, J., Breno, M., Leirs, H., 2014. A novel method to reduce time investment when processing videos from camera trap studies. PLoS ONE 9, e98881.

Symes, C.T., 2017. Notes on the flowering and pollination of the endemic grassland *Aloe reitzii* var. *reitzii* (Asphodelaceae). Bothalia-African Biodiversity & Conservation 47, a2215.

Tambling, C.J., Minnie, L., Adendorff, J., Kerley, G.I., 2013. Elephants facilitate impact of large predators on small ungulate prey species. Basic and Applied Ecology 14, 694-701.

Tobler, M.W., Carrillo-Percastegui, S.E., Leite Pitman, R., Mares, R., Powell, G., 2008. An evaluation of camera traps for inventorying large-and medium-sized terrestrial rainforest mammals. Animal conservation 11, 169-178.

Torrents-Ticó, M., Rich, L., McNutt, J.W., Nthomiwa, M., Mothala, M., Motsamai, G., Jordan, N.R., 2017. On the right track? Comparing concurrent spoor and camera-trap surveys in Botswana. African Journal of Wildlife Research 47, 128-137.

Torrents-Ticó, M., Fernández-Llamazares, Á., Burgas, D., Cabeza, M., 2021. Convergences and divergences between scientific and indigenous and local knowledge contribute to inform carnivore conservation. Ambio 50, 990-1002.

Tosso, F., Cherchye, G., Hardy, O.J., Daïnou, K., Lognay, G., Tagg, N., Haurez, B., Souza, A., Heuskin, S., Doucet, J.L., 2018. Characterization of animal communities involved in seed dispersal and predation of *Guibourtia tessmannii* (Harms) J. Léonard, a species newly listed on Appendix II of CITES. African Journal of Ecology 56, 468-476.

Treves, A., Mwima, P., Plumptre, A.J., Isoke, S., 2010. Camera-trapping forest–woodland wildlife of western Uganda reveals how gregariousness biases estimates of relative abundance and distribution. Biological Conservation 143, 521-528.

Tshabalala, T., McManus, J., Treves, A., Masocha, V., Faulconbridge, S., Schurch, M., Goets, S., Smuts, B., 2021. Leopards and mesopredators as indicators of mammalian species richness across diverse landscapes of South Africa. Ecological Indicators 121, 107201.

Turikunkiko, E., Mulindahabi, F., Gatorano, G., Muvunyi, R., Ntihemuka, P., Niyigaba, P., Ndikubwimana, I., Karegire, N., Moore, J.F., 2021. Resighting African wildcats (*Felis lybica*): Camera trap photographs in Nyungwe National Park, Rwanda. African Journal of Ecology 60, 71-74.

van Berkel, T., Sumbane, E., Jones, S.E., Jocque, M., 2019. A mammal survey of the Serra Jeci Mountain Range, Mozambique, with a review of records from northern Mozambique's inselbergs. African Zoology 54, 31-42.

Van der Weyde, L.K., Mbisana, C., Klein, R., 2018. Multi-species occupancy modelling of a carnivore guild in wildlife management areas in the Kalahari. Biological Conservation 220, 21-28.

Van der Weyde, L.K., Theisinger, O., Mbisana, C., Gielen, M.C., Klein, R., 2022. The value of pastoral ranches for wildlife conservation in the Kalahari. Wildlife Research 49, 215–226.

Van Opstal, M., Oosterlynck, B., Belay, M., Erens, J., De Beenhouwer, M., 2019. First assessment of bird diversity in the UNESCO Sheka Forest Biosphere Reserve, southwestern Ethiopia: species richness, distribution and potential for avian conservation. Journal of Threatened Taxa 11, 13850-13867.

Vanthomme, H., Kolowski, J., Korte, L., Alonso, A., 2013. Distribution of a community of mammals in relation to roads and other human disturbances in Gabon, Central Africa. Conservation Biology 27, 281-291.

Veldhuis, M.P., Hofmeester, T.R., Balme, G., Druce, D.J., Pitman, R.T., Cromsigt, J.P., 2020. Predation risk constrains herbivores’ adaptive capacity to warming. Nature Ecology & Evolution 4, 1069-1074.

Verschueren, S., Briers-Louw, W.D., Monterroso, P., Marker, L., 2021. Local-scale variation in land use practice supports a diverse carnivore guild on Namibian multiple-use rangeland. Rangeland Ecology & Management 79, 64-76.

Webber, A.D., Solofondranohatra, J.S., Razafindramoana, S., Fernández, D., Parker, C.A., Steer, M., Abrahams, M., Allainguillaume, J., 2020. Lemurs in cacao: presence and abundance within the shade plantations of Northern Madagascar. Folia Primatologica 91, 96-107.

Webster, A.B., Pretorius, M.E., Somers, M.J., 2021. The determinants of mesocarnivore activity patterns in highveld grassland and riparian habitats. African Journal of Wildlife Research 51, 178-192.

Welch, R.J., Grant, T., Parker, D.M., 2019. Using camera traps to generate a species inventory for medium-sized and large mammals in South West Zimbabwe. African Journal of Wildlife Research 49, 89-99.

Wells, H.B., Kimuyu, D.M., Odadi, W.O., Dougill, A.J., Stringer, L.C., Young, T.P., 2021. Wild and domestic savanna herbivores increase smaller vertebrate diversity, but less than additively. Journal of Applied Ecology 58, 953-963.

Wentzel, J., Gall, C., Bourn, M., De Beer, J., du Plessis, F., Fosgate, G.T., 2021. Carnivore detection at the domestic/wildlife interface within Mpumalanga Province, South Africa. Animals 11, 2535.

White, J.D., Bronner, G.N., Midgley, J.J., 2017. Camera-trapping and seed-labelling reveals widespread granivory and scatter-hoarding of nuts by rodents in the Fynbos Biome. African Zoology 52, 31-41.

Whytock, R.C., Abwe, E.E., Mfossa, D.M., Ketchen, M.E., Abwe, A.E., Nguimdo, V.R.V., Maisels, F., Strindberg, S., Morgan, B.J., 2021. Mammal distribution and trends in the threatened Ebo'intact forest landscape', Cameroon. Global Ecology and Conservation 31, e01833.

Widness, J., Aronsen, G.P., 2018. Camera trap data on mammal presence, behaviour and poaching: a case study from Mainaro, Kibale National Park, Uganda. African Journal of Ecology 56, 383-389.

Wilkinson, C.E., McInturff, A., Kelly, M., Brashares, J.S., 2021. Quantifying wildlife responses to conservation fencing in East Africa. Biological Conservation 256, 109071.

Williams, D., Pettorelli, N., Henschel, J., Cowlishaw, G., Douglas, C.M., 2014. Impact of alien trees on mammal distributions along an ephemeral river in the Namib Desert. African Journal of Ecology 52, 404-413.

Williams, S.T., Maree, N., Taylor, P., Belmain, S.R., Keith, M., Swanepoel, L.H., 2018a. Camera trap and questionnaire dataset on ecosystem services provided by small carnivores in agro-ecosystems in South Africa. Data in Brief 18, 753-759.

Williams, S.T., Maree, N., Taylor, P., Belmain, S.R., Keith, M., Swanepoel, L.H., 2018b. Predation by small mammalian carnivores in rural agro-ecosystems: an undervalued ecosystem service? Ecosystem Services 30, 362-371.

Wood, B.M., Millar, R.S., Wright, N., Baumgartner, J., Holmquist, H., Kiffner, C., 2021. Hunter-Gatherers in context: Mammal community composition in a northern Tanzania landscape used by Hadza foragers and Datoga pastoralists. PLoS One 16, e0251076.

Zungu, M.M., Maseko, M.S.T., Kalle, R., Ramesh, T., Downs, C.T., 2019. Fragment and life-history correlates of extinction vulnerability of forest mammals in an urban-forest mosaic in EThekwini Municipality, Durban, South Africa. Animal Conservation 22, 362-375.

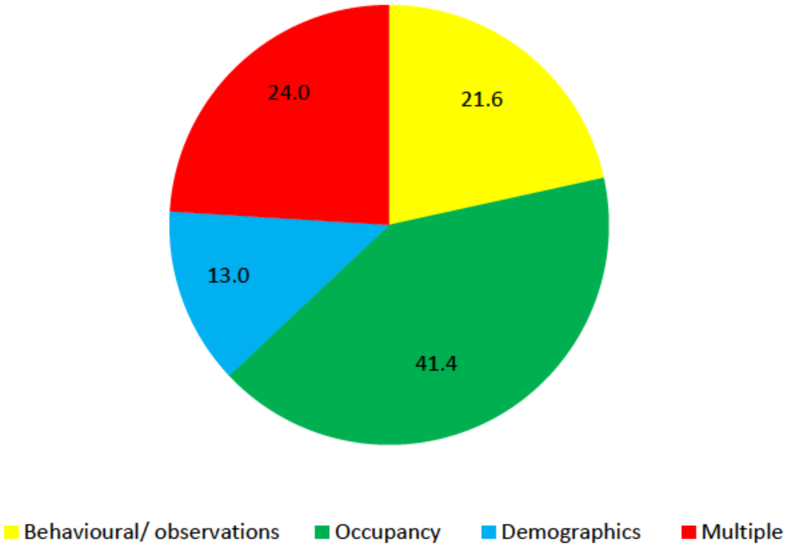
Zungu, M.M., Maseko, M.S.T., Kalle, R., Ramesh, T., Downs, C.T. 2020a. Factors affecting the occupancy of forest mammals in an urban-forest mosaic in EThekwini Municipality, Durban, South Africa. Urban Forestry & Urban Greening 48, 126562. https://doi.org/10.1016/j.ufug.2019.126562

Zungu, M.M., Maseko, M.S.T., Kalle, R., Ramesh, T., Downs, C.T. 2020b. Effects of landscape context on mammal richness in the urban forest mosaic of EThekwini Municipality, Durban, South Africa. Global Ecology and Conservation 21, e00878. https://doi.org/10.1016/j.gecco.2019.e00878.

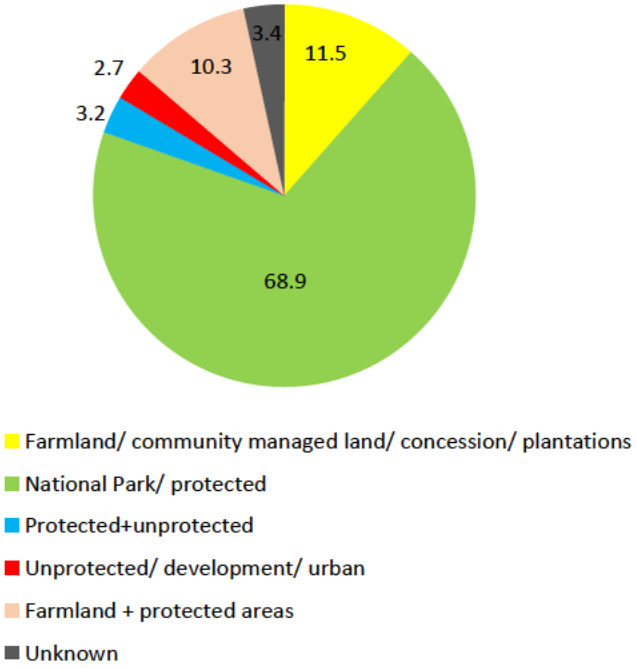
2.7 Supplementary Information

Supplementary Information Table S2.1. Search strings used to document camera trap research in Africa in the present study

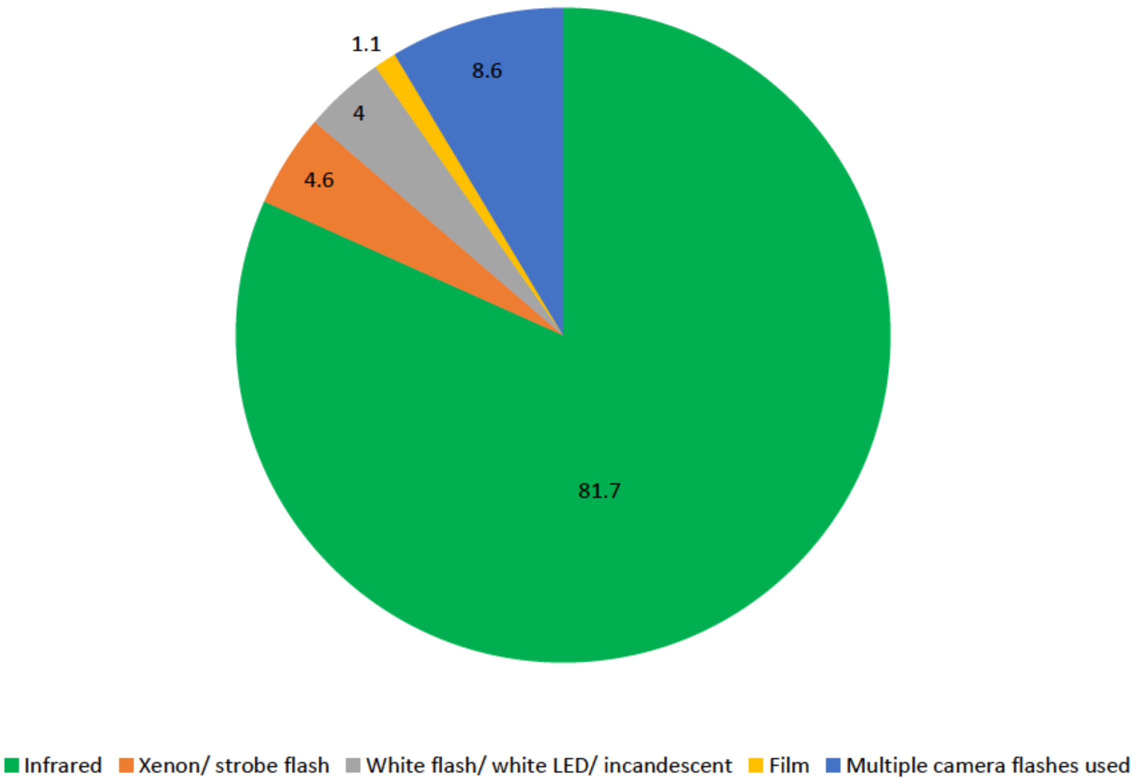
Web of Science^{TM} search string: TS=((camera trap* OR remote camera* OR infrared triggered camera* OR trail camera* OR automatic camera* OR photo trap* OR remotely triggered camera*) AND (Africa OR Algeria OR Angola OR Benin OR Botswana OR Burkina Faso OR Burundi OR Cameroon OR Cape Verde OR Central African Republic OR Chad OR Comoros OR Democratic Republic of the Congo OR Republic of the Congo OR Djibouti OR Egypt OR Equatorial Guinea OR Eritrea OR Eswatini OR Ethiopia OR Gabon OR Gambia OR Ghana OR Guinea OR Guinea-Bissau OR Ivory Coast OR Kenya OR Lesotho OR Liberia OR Libya OR Madagascar OR Malawi OR Mali OR Mauritania OR Mauritius OR Morocco OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR São Tomé and Príncipe OR Senegal OR Seychelles OR Sierra Leone OR Somalia OR South Africa OR South Sudan OR Sudan OR Swaziland OR Tanzania OR Togo OR Tunisia OR Uganda OR Zambia OR Zimbabwe)).
Scopus search string: ((camera trap)) OR ((remote camera)) OR ((infrared triggered camera)) OR ((trail camera)) OR ((automatic camera)) OR ((photo trap)) OR ((remotely triggered camera)) AND (Africa) OR (Algeria) OR (Angola) OR (Benin) OR (Botswana) OR (Burkina Faso) OR (Burundi) OR (Cameroon) OR (Central African Republic) OR (Chad) OR (Comoros) OR (Democratic Republic of the Congo) OR (Republic of the Congo) OR (Djibouti) OR (Egypt) OR (Equatorial Guinea) OR (Eritrea) OR (Eswatini) OR (Ethiopia) OR (Gabon) OR (Gambia) OR (Ghana) OR (Guinea) OR (Guinea-Bissau) OR (Ivory Coast) OR (Kenya) OR (Lesotho) OR (Liberia) OR (Libya) OR (Madagascar) OR (Malawi) OR (Mali) OR (Mauritania) OR (Mauritius) OR (Morocco) OR (Mozambique) OR (Namibia) OR (Niger) OR (Nigeria) OR (Rwanda) OR (São Tomé and Príncipe) OR (Senegal) OR (Seychelles) OR (Sierra Leone) OR (Somalia) OR (South Africa) OR (South Sudan) OR (Sudan) OR (Swaziland) OR (Tanzania) OR (Togo) OR (Tunisia) OR (Uganda) OR (Zambia) OR (Zimbabwe).



Supplementary Information Figure S2.1. Summary of the study objectives used in the camera trap studies conducted in Africa from 2005-2021 and the percentage use of each.



Supplementary Information Figure S2.2. Summary of the land use types receiving focus in those camera trap studies conducted in Africa from 2005-2021.



Supplementary Information Figure S2.3. Summary of the types of camera trap flashes used and the percentage use of each flash type from the total studies which reported camera flash type.

Supplementary Information Table S2.2. Summary of camera trap publications in Africa from 2005-2021 used in the review.

No.	Full Reference
1	Abade, L., Cusack, J., Moll, R.J., Strampelli, P., Dickman, A.J., Macdonald, D.W., Montgomery, R.A., 2018. Spatial variation in leopard (*Panthera pardus*) site use across a gradient of anthropogenic pressure in Tanzania's Ruaha landscape. PLoS ONE 13(10), e0204370.
2	Abade, L., Cusack, J., Moll, R.J., Strampelli, P., Dickman, A.J., Macdonald, D.W., Montgomery, R.A., 2020. The relative effects of prey availability, anthropogenic pressure and environmental variables on lion (*Panthera leo*) site use in Tanzania's Ruaha landscape during the dry season. Journal of Zoology 310, 135-144.
3	Abu Baker, M.A., Brown, J.S., 2014. Foraging and habitat use of common duikers, *Sylvicapra grimmia*, in a heterogeneous environment within the Soutpansberg, South Africa. African Journal of Ecology 52, 318-327.
4	Adams, T.S., Chase, M.J., Rogers, T.L., Leggett, K.E., 2017. Taking the elephant out of the room and into the corridor: can urban corridors work? Oryx 51, 347-353.
5	Aebischer, T., Siguindo, G., Rochat, E., Arandjelovic, M., Heilman, A., Hickisch, R., Vigilant, L., Joost, S., Wegmann, D., 2017. First quantitative survey delineates the distribution of chimpanzees in the Eastern Central African Republic. Biological Conservation 213, 84-94.
6	Aebischer, T., Ibrahim, T., Hickisch, R., Furrer, R.D., Leuenberger, C., Wegmann, D., 2020. Apex predators decline after an influx of pastoralists in former Central African Republic hunting zones. Biological Conservation 241, 108326.
7	Ahumada, J.A., Silva, C.E., Gajapersad, K., Hallam, C., Hurtado, J., Martin, E., McWilliam, A., Mugerwa, B., O'Brien, T., Rovero, F., Sheil, D., Spironello, W.R., Winarni, N., Andelman, S.J., 2011. Community structure and diversity of tropical forest mammals: data from a global camera trap network. Philosophical Transactions of the Royal Society B: Biological Sciences 366, 2703-2711.
8	Alempijevic, D., Boliabo, E.M., Coates, K.F., Hart, T.B., Hart, J.A., Detwiler, K.M., 2021. A natural history of *Chlorocebus dryas* from camera traps in Lomami National Park and its buffer zone, Democratic Republic of the Congo, with notes on the species status of *Cercopithecus salongo*. American Journal of Primatology 83, e23261.
9	Alexander, K.A., Nichols, C.A., 2020. Behavior-landscape interactions may create super-spreader environments: vigilance-olfactory interactions across land type and disease transmission potential in the banded mongoose. Frontiers in Ecology and Evolution 8, 1-10.
10	Allen, M.L., Peterson, B., Krofel, M., 2018. No respect for apex carnivores: distribution and activity patterns of honey badgers in the Serengeti. Mammalian Biology 89, 90-94.
11	Amin, R., Andanje, S.A., Ogwonka, B., Ali, A.H., Bowkett, A.E., Omar, M., Wacher, T., 2015. The northern coastal forests of Kenya are nationally and globally important for the conservation of Aders' duiker *Cephalophus adersi* and other antelope species. Biodiversity and Conservation 24, 641-658.
12	Amin, R., Klair, H., Wacher, T., Ndjassi, C., Fowler, A., Olson, D., Bruce, T., 2021a. Estimating forest antelope population densities using distance sampling with camera traps. Oryx 56, 345-351.
13	Amin, R., Wacher, T., Ogwoka, B., Khayale, C., Kariuki, L., Agwanda, B., 2021b. Habitat use of the endangered golden-rumped sengi *Rhynchocyon chrysopygus*. African Journal of Ecology 59, 108-116.
14	Amoroso, C.R., Kappeler, P.M., Fichtel, C., Nunn, C.L., 2020. Temporal patterns of waterhole use as a predator avoidance strategy. Journal of Mammalogy 101, 574-581.
15	Andanje, S.A., Bowkett, A.E., Agwanda, B.R., Ngaruiya, G.W., Plowman, A.B., Wacher, T., Amin, R., 2011. A new population of the critically endangered Aders' duiker *Cephalophus adersi* confirmed from northern coastal Kenya. Oryx 45, 444-447.

16 Anderson, T.M., White, S., Davis, B., Erhardt, R., Palmer, M., Swanson, A., Kosmala, M., Packer, C., 2016. The spatial distribution of African savannah herbivores: species associations and habitat occupancy in a landscape context. Philosophical Transactions of the Royal Society B: Biological Sciences 371, 20150314.

17 Anderson, J.R., Hubert-Brierre, X., McGrew, W.C., 2017. Reflections in the rainforest: full-length mirrors facilitate behavioral observations of unhabituated, wild chimpanzees. Primates 58, 51-61.

18 Andresen, L., Everatt, K.T., Somers, M.J., Purchase, G.K., 2012. Evidence for a resident population of cheetah in the Parque Nacional do Limpopo, Mozambique. African Journal of Wildlife Research 42, 144-146.

19 Andresen, L., Everatt, K.T., Somers, M.J., 2014. Use of site occupancy models for targeted monitoring of the cheetah. Journal of Zoology 292, 212-220.

20 Angelici, F.M., Di Vittorio, M., Petrozzi, F., 2012. New records of a threatened lion population (*Panthera leo*) in a West African national park. African Zoology 47, 353-357.

21 Araldi, A., Zambarda, A., Giacoma, C., Gamba, M., 2012. Primates as Leopards Prey in Western Soutpansberg, South Africa. In XX CONGRESSO NAZIONALE ASSOCIAZIONE PRIMATOLOGICA ITALIANA-I Primati: Biodiversità e Conservazione 82, 269-270).

22 Assou, D., D'Cruze, N., Kirkland, H., Auliya, M., Macdonald, D.W., Segniagbeto, G.H., 2021. Camera trap survey of mammals in the Fazao-Malfakassa National Park, Togo, West Africa. African Journal of Ecology 59, 583-596.

23 Bahaa-el-din, L., Sollmann, R., Hunter, L.T., Slotow, R., Macdonald, D.W., Henschel, P., 2016. Effects of human land-use on Africa's only forest-dependent felid: The African golden cat Caracal aurata. Biological Conservation 199, 1-9.

24 Balme, G.A., Hunter, L.T., Slotow, R.O.B., 2009a. Evaluating methods for counting cryptic carnivores. The Journal of Wildlife Management 73, 433-441.

25 Balme, G.A., Slotow, R., Hunter, L.T., 2009b. Impact of conservation interventions on the dynamics and persistence of a persecuted leopard (Panthera pardus) population. Biological Conservation 142, 2681-2690.

26 Balme, G., Rogan, M., Thomas, L., Pitman, R., Mann, G., Whittington-Jones, G., Midlane, N., Broodryk, M., Broodryk, K., Campbell, M., Alkema, M., Wright, D., Hunter, L., 2019. Big cats at large: density, structure, and spatio-temporal patterns of a leopard population free of anthropogenic mortality. Population Ecology 61, 256-267.

27 Barandongo, Z.R., Mfune, J.K., Turner, W.C., 2018. Dust-bathing behaviors of African herbivores and the potential risk of inhalational anthrax. Journal of Wildlife Diseases 54, 34-44.

28 Beattie, K., Olson, E.R., Kissui, B., Kirschbaum, A., Kiffner, C., 2020. Predicting livestock depredation risk by African lions (*Panthera leo*) in a multi-use area of northern Tanzania. European Journal of Wildlife Research 66, 11.

29 Beaudrot, L., Palmer, M.S., Anderson, T.M., Packer, C., 2020. Mixed-species groups of Serengeti grazers: a test of the stress gradient hypothesis. Ecology 101, e03163.

30 Belbachir, F., Pettorelli, N., Wacher, T., Belbachir-Bazi, A., Durant, S.M., 2015. Monitoring rarity: the critically endangered Saharan cheetah as a flagship species for a threatened ecosystem. PLoS ONE 10, e0115136.

31 Bersacola, E., Hill, C.M., Hockings, K.J., 2021. Chimpanzees balance resources and risk in an anthropogenic landscape of fear. Scientific Reports 11, 1-13.

32 Bessa, J., Hockings, K., Biro, D., 2021. First evidence of chimpanzee extractive tool use in Cantanhez, Guinea-Bissau: Cross-community variation in honey dipping. Frontiers in Ecology and Evolution 9, 625303.

33 Bessone, M., Kühl, H.S., Hohmann, G., Herbinger, I., N'Goran, K.P., Asanzi, P., Da Costa, P., Dérozier, V., Fotsing, E.D.B., Beka, B.I., Iyomi, M.D., Iyatshi, I.B., Kafando, P., Kambere, M.A., Moundzoho, D.B., Wanzalire, M.L.K., Fruth, B., 2020. Drawn out of the shadows: surveying secretive forest species with camera trap distance sampling. Journal of Applied Ecology 57, 963-974.

34 Bissessur, P., Bunsy, Y., Baider, C., Florens, F.B.V., 2019. Non-intrusive systematic study reveals mutualistic interactions between threatened island endemic species and points to more impactful conservation. Journal for Nature Conservation 49, 108-117.

35 Boesch, C., Kalan, A.K., Agbor, A., Arandjelovic, M., Dieguez, P., Lapeyre, V., Kühl, H.S., 2017. Chimpanzees routinely fish for algae with tools during the dry season in Bakoun, Guinea. American Journal of Primatology 79, e22613.

36 Bohm, T., Hofer, H., 2018. Population numbers, density and activity patterns of servals in savannah patches of Odzala-Kokoua National Park, Republic of Congo. African Journal of Ecology 56, 841-849.

37 Bowkett, A.E., Rovero, F., Marshall, A.R., 2008. The use of camera-trap data to model habitat use by antelope species in the Udzungwa Mountain forests, Tanzania. African Journal of Ecology 46, 479-489.

38 Boyer-Ontl, K.M., Pruetz, J.D., 2014. Giving the forest eyes: the benefits of using camera traps to study unhabituated chimpanzees (Pan troglodytes verus) in southeastern Senegal. International Journal of Primatology 35, 881-894.

39 Boyer-Ontl, K., Pruetz, J.D., 2020. Mothers frequent caves: lactation affects chimpanzee (*Pan troglodytes verus*) cave use in southeastern Senegal. International Journal of Primatology, 1-20.

40 Braczkowski, A., Watson, L., Coulson, D., Randall, R., 2012. Diet of leopards in the southern Cape, South Africa. African Journal of Ecology 50, 377.

41 Braczkowski, A.R., Balme, G.A., Dickman, A., Macdonald, D.W., Fattebert, J., Dickerson, T., Johnson, P., Hunter, L., 2015. Who bites the bullet first? The susceptibility of leopards *Panthera pardus* to trophy hunting. PLoS One 10, e0123100.

42 Braczkowski, A.R., Balme, G.A., Dickman, A., Fattebert, J., Johnson, P., Dickerson, T., Macdonald, D.W., Hunter, L., 2016. Scent lure effect on camera-trap based leopard density estimates. PLoS ONE 11, e0151033.

43 Brandlová, K., Gloneková, M., Hejcmanová, P., Jůnková Vymyslická, P., Aebischer, T., Hickisch, R., Mallon, D., 2018. Chinko/Mbari drainage basin represents a conservation hotspot for eastern Derby eland in Central Africa. African Journal of Ecology 56, 194-201.

44 Brassine, E., Parker, D., 2015. Trapping elusive cats: using intensive camera trapping to estimate the density of a rare African felid. PLoS ONE 10, e0142508.

45 Broeckhoven, C., Mouton, P.L.F.N., 2015. Some like it hot: camera traps unravel the effects of weather conditions and predator presence on the activity levels of two lizards. PLoS One 10, e0137428.

46 Bruce, T., Amin, R., Wacher, T., Fankem, O., Ndjassi, C., Ngo Bata, M., Fowler, A., Ndinga, H., Olson, D., 2018a. Using camera trap data to characterise terrestrial larger-bodied mammal communities in different management sectors of the Dja Faunal Reserve, Cameroon. African Journal of Ecology 56, 759-776.

47 Bruce, T., Kamta, R., Tabue Mbobda, R.B., Talla Kanto, S., Djibrilla, D., Moses, I., Deblauwe, V., Njabo, K., LeBreton, M., Ndjassi, C., Barichievy, C., Olsen, D., 2018b. Locating giant ground pangolins (Smutsia gigantea) using camera traps on burrows in the Dja Biosphere Reserve, Cameroon. Tropical Conservation Science 11, 1-5.

48 Brzeski, K.E., Wolfe, J.D., Ebana Ebana, C., Cooper, J.C., Powell, L.L., 2016. Camera sighting of Congo clawless otter in the midst of a rapid development on mainland Equatorial Guinea. IUCN Otter Spec. Group Bulletin 33, 96-101.

49 Burt, C., Fritz, H., Keith, M., Guerbois, C., Venter, J.A., 2021. Assessing different methods for measuring mammal diversity in two southern African arid ecosystems. Mammal Research 66, 313-326.

50 Burton, A.C., Sam, M.K., Kpelle, D.G., Balangtaa, C., Buedi, E.B., Brashares, J.S., 2011. Evaluating persistence and its predictors in a West African carnivore community. Biological Conservation 144, 2344-2353.

51 Burton, A.C., Sam, M.K., Balangtaa, C., Brashares, J.S., 2012. Hierarchical multi-species modeling of carnivore responses to hunting, habitat and prey in a West African protected area. PLoS ONE 7, e38007.

52 Buschke, F.T., 2016. A camera trap survey of nocturnal mammals on former farmland in the eastern Free State Province, South Africa, 10 years after removing livestock. African Journal of Ecology 54, 514-518.

53 Cardoso, A.W., Malhi, Y., Oliveras, I., Lehmann, D., Ndong, J.E., Dimoto, E., Bush, E., Jeffery, K., Labriere, N., Lewis, S.L., White, L.T.J., Bond, W., Abernathy, K., 2020. The role of forest elephants in shaping tropical forest–savanna coexistence. Ecosystems 23, 602-616.

54 Castells, D.E., Elizalde, S.R., Ceríaco, L.M., Groom, R.J., 2021. Ansorge’s cusimanse in Angola: 100 years apart, new records contribute to the species known range. Mammalia 85, 389-395.

55 Cavada, N., Worsøe Havmøller, R., Scharff, N., Rovero, F., 2019. A landscape-scale assessment of tropical mammals reveals the effects of habitat and anthropogenic disturbance on community occupancy. PLoS ONE 14, e0215682.

56 Chapman, S., Balme, G., 2010. An estimate of leopard population density in a private reserve in KwaZulu-Natal, South Africa, using camera—traps and capture-recapture models. African Journal of Wildlife Research 40, 114-120.

57 Chen, D.M., Narváez-Torres, P.R., Tiafinjaka, O., Farris, Z.J., Rasoloharijaona, S., Louis, E.E., Johnson, S.E., 2021. Lemur paparazzi: Arboreal camera trapping and occupancy modeling as conservation tools for monitoring threatened lemur species. American Journal of Primatology 83, e23270.

58 Clauss, M., Scriba, M., Kioko, J., Ganzhorn, J.U., Kiffner, C., 2021. Camera-trap data do not indicate scaling of diel activity and cathemerality with body mass in an East African mammal assemblage. Ecology and Evolution 11, 13846-13861.

59 Collen, B., Howard, R., Konie, J., Daniel, O., Rist, J., 2011. Field surveys for the endangered pygmy hippopotamus *Choeropsis liberiensis* in Sapo National Park, Liberia. Oryx 45, 35-37.

60 Colyn, R.B., Campbell, A.M., Smit-Robinson, H.A., 2017. The application of camera trapping to assess Rallidae species richness within palustrine wetland habitat in South Africa. Ostrich 88, 235-245.

61 Colyn, R.B., Campbell, A.M., Smit-Robinson, H.A., 2019. Camera-trapping successfully and non-invasively reveals the presence, activity and habitat choice of the critically endangered white-winged Flufftail Sarothrura ayresi in a South African high-altitude wetland. Bird Conservation International 29, 463-478.

62 Colyn, R., Campbell, A., Smit-Robinson, H., 2020. The use of a camera trap and acoustic survey design to ascertain the vocalization and breeding status of the highly elusive White-winged Flufftail, *Sarothrura ayresi*. Avian Conservation and Ecology 15, 12.

63 Combrink, X., Warner, J.K., Downs, C.T., 2016. Nest predation and maternal care in the Nile crocodile (*Crocodylus niloticus*) at Lake St Lucia, South Africa. Behavioural Processes 133, 31-36.

64 Comley, J., Joubert, C.J., Mgqatsa, N., Parker, D.M., 2020. Lions do not change rivers: complex African savannas preclude top-down forcing by large carnivores. Journal for Nature Conservation 56, 125844.

65 Connolly, E., Allan, J., Brehony, P., Aduda, A., Western, G., Russell, S., Dickman, A., Tyrrell, P., 2021. Coexistence in an African pastoral landscape: Evidence that livestock and wildlife temporally partition water resources. African Journal of Ecology 59, 696-711.

66 Cornhill, K.L., Kerley, G.I., 2020. Cheetah communication at scent-marking sites can be inhibited or delayed by predators. Behavioral Ecology and Sociobiology 74, 21.

67 Coverdale, T.C., Kartzinel, T.R., Grabowski, K.L., Shriver, R.K., Hassan, A.A., Goheen, J.R., Palmer, T.M., Pringle, R.M., 2016. Elephants in the understory: opposing direct and indirect effects of consumption and ecosystem engineering by megaherbivores. Ecology 97, 3219-3230.

68 Cozzi, G., Börger, L., Hutter, P., Abegg, D., Beran, C., McNutt, J.W., Ozgul, A., 2015. Effects of trophy hunting leftovers on the ranging behaviour of large carnivores: A case study on spotted hyenas. PLoS ONE 10, e0121471.

69 Crawford, C.L., Volenec, Z.M., Sisanya, M., Kibet, R., Rubenstein, D.I., 2019. Behavioral and Ecological Implications of Bunched, Rotational Cattle Grazing in East African Savanna Ecosystem. Rangeland Ecology & Management 72, 204-209.

70 Cronk, N.E., Pillay, N., 2019. Flexible Use of Urban Resources by the Yellow Mongoose *Cynictis penicillata*. Animals 9, 447.

71 Cronk, N.E., Pillay, N., 2020. Spatiotemporal co-occurrence and overlap of two sympatric mongoose species in an urban environment. Journal of Urban Ecology 6, juaa013.

72 Crunchant, A.S., Borchers, D., Kühl, H., Piel, A., 2020. Listening and watching: Do camera traps or acoustic sensors more efficiently detect wild chimpanzees in an open habitat? Methods in Ecology and Evolution 11, 542-552.

73 Curveira-Santos, G., Sutherland, C., Santos-Reis, M., Swanepoel, L.H., 2021a. Responses of carnivore assemblages to decentralized conservation approaches in a South African landscape. Journal of Applied Ecology 58, 92-103.

74 Curveira-Santos, G., Sutherland, C., Tenan, S., Fernández-Chacón, A., Mann, G.K., Pitman, R.T., Swanepoel, L.H., 2021b. Mesocarnivore community structuring in the presence of Africa's apex predator. Proceedings of the Royal Society B 288, 20202379.

75 Cusack, J. J., Swanson, A., Coulson, T., Packer, C., Carbone, C., Dickman, A.J., Kosmala, M., Lintott, C., Rowcliffe, J.M., 2015a. Applying a random encounter model to estimate lion density from camera traps in Serengeti National Park, Tanzania. Journal of Wildlife Management 79, 1014-1021.

76 Cusack, J.J., Dickman, A.J., Rowcliffe, J.M., Carbone, C., Macdonald, D.W., Coulson, T., 2015b. Random versus game trail-based camera trap placement strategy for monitoring terrestrial mammal communities. PLoS ONE 10, e0126373.

77 Cusack, J.J., Dickman, A.J., Kalyahe, M., Rowcliffe, J.M., Carbone, C., MacDonald, D.W., Coulson, T., 2017. Revealing kleptoparasitic and predatory tendencies in an African mammal community using camera traps: a comparison of spatiotemporal approaches. Oikos 126, 812-822.

78 Davies, A.B., Tambling, C.J., Kerley, G.I., Asner, G.P., 2016. Limited spatial response to direct predation risk by African herbivores following predator reintroduction. Ecology and Evolution 6, 5728-5748.

79 Davis, R.S., Stone, E.L., Gentle, L.K., Mgoola, W.O., Uzal, A., Yarnell, R.W., 2021a. Spatial partial identity model reveals low densities of leopard and spotted hyaena in a miombo woodland. Journal of Zoology 313, 43-53.

80 Davis, R.S., Yarnell, R.W., Gentle, L.K., Uzal, A., Mgoola, W.O., Stone, E.L., 2021b. Prey availability and intraguild competition regulate the spatiotemporal dynamics of a modified large carnivore guild. Ecology and Evolution 11, 7890-7904.

81 De Beenhouwer, M., Mertens, J., Habtamu, T., 2016. Camera trap observation of crested rat (*Lophiomys imhausi*, Muroidea: Rodentia) in Belete-Gera montane rainforest, south-western Ethiopia. African Journal of Ecology 54, 111-113.

82 De Luca, D.W., Rovero, F., 2006. First records in Tanzania of the vulnerable Jackson's mongoose *Bdeogale jacksoni* (Herpestidae). Oryx 40, 468-471.

83 de Satgé, J., Teichman, K., Cristescu, B., 2017. Competition and coexistence in a small carnivore guild. Oecologia 184, 873-884.

84 Després-Einspenner, M.L., Howe, E.J., Drapeau, P., Kühl, H.S., 2017. An empirical evaluation of camera trapping and spatially explicit capture-recapture models for estimating chimpanzee density. American Journal of Primatology 79, e22647.

85 Devens, C., Tshabalala, T., McManus, J., Smuts, B., 2018. Counting the spots: The use of a spatially explicit capture–recapture technique and GPS data to estimate leopard (Panthera pardus) density in the Eastern and Western Cape, South Africa. African Journal of Ecology 56, 850-859.

86 Devens, C.H., Hayward, M.W., Tshabalala, T., Dickman, A., McManus, J.S., Smuts, B., Somers, M.J., 2021. Estimating leopard density across the highly modified human-dominated landscape of the Western Cape, South Africa. Oryx 55, 34-45.

87 Drouilly, M., O'Riain, M.J., 2019. Wildlife winners and losers of extensive small-livestock farming: a case study in the South African Karoo. Biodiversity and Conservation 28, 1493-1511.

88 Drouilly, M., Clark, A., O'Riain, M.J., 2018. Multi-species occupancy modelling of mammal and ground bird communities in rangeland in the Karoo: a case for dryland systems globally. Biological Conservation 224, 16-25.

89 du Preez, B.D., Loveridge, A.J., Macdonald, D.W., 2014. To bait or not to bait: a comparison of camera-trapping methods for estimating leopard *Panthera pardus* density. Biological Conservation 176, 153-161.

90 Dupuis-Desormeaux, M., Davidson, Z., Mwololo, M., Kisio, E., Taylor, S., MacDonald, S.E., 2015. Testing the prey-trap hypothesis at two wildlife conservancies in Kenya. PLoS ONE 10, e0139537.

91 Dupuis-Desormeaux, M., Davidson, Z., Mwololo, M., Kisio, E., MacDonald, S.E., 2016a. Comparing motion capture cameras versus human observer monitoring of mammal movement through fence gaps: a case study from Kenya. African Journal of Ecology 54, 154-161.

92 Dupuis-Désormeaux, M., Davidson, Z., Mwololo, M., Kisio, E., MacDonald, S.E., 2016b. Usage of specialized fence-gaps in a black rhinoceros conservancy in Kenya. African Journal of Wildlife Research 46, 22-32.

93 Dupuis-Desormeaux, M., Kaaria, T.N., Mwololo, M., Davidson, Z., MacDonald, S.E., 2018. A ghost fence-gap: surprising wildlife usage of an obsolete fence crossing. PeerJ 6, e5950.

94 Easter, T., Bouley, P., Carter, N., 2019. Opportunities for biodiversity conservation outside of Gorongosa National Park, Mozambique: a multispecies approach. Biological Conservation 232, 217-227.

95 Easter, T., Bouley, P., Carter, N., 2020. Intraguild dynamics of understudied carnivores in a human-altered landscape. Ecology and Evolution 10, 5476–5488.

96 Easton, J., Chao, N., Mulindahabi, F., Ntare, N., Rugyerinyange, L., Ndikubwimana, I., 2011. Status and conservation of the only population of the vulnerable owl-faced monkey *Cercopithecus hamlyni* in Rwanda. Oryx 45, 435-438.

97 Edwards, S., Gange, A.C., Wiesel, I., 2015. Spatiotemporal resource partitioning of water sources by African carnivores on Namibian commercial farmlands. Journal of Zoology 297, 22-31.

98 Edwards, S., Gange, A.C., Wiesel, I., 2016. An oasis in the desert: the potential of water sources as camera trap sites in arid environments for surveying a carnivore guild. Journal of Arid Environments 124, 304-309.

99 Edwards, S., Cooper, S., Uiseb, K., Hayward, M., Wachter, B., Melzheimer, J., 2018a. Making the most of by-catch data: assessing the feasibility of utilising non-target camera trap data for occupancy modelling of a large felid. African Journal of Ecology 56, 885-894.

100 Edwards, S., Fischer, M., Wachter, B., Melzheimer, J., 2018b. Coping with intrasexual behavioral differences: capture–recapture abundance estimation of male cheetah. Ecology and Evolution 8, 9171-9180.

101 Edwards, S., Portas, R., Hanssen, L., Beytell, P., Melzheimer, J., Stratford, K., 2018c. The spotted ghost: density and distribution of serval *Leptailurus serval* in Namibia. African Journal of Ecology 56, 831-840.

102 Edwards, S., Noack, J., Heyns, L., Rodenwoldt, D., 2019. Evidence of a high-density brown hyena population within an enclosed reserve: the role of fenced systems in conservation. Mammal Research 64, 519-527.

103 Edwards, S., Noack, J., Heyns, L., Rodenwoldt, D., Tarjan, L.M., 2020. Socioecology of a high-density brown hyaena population within an enclosed reserve. Mammal Research, 1-11.

104 Ehlers Smith, D.A., Ehlers Smith, Y.C., Ramesh, T., Downs, C.T., 2017a. Camera-trap data elucidate habitat requirements and conservation threats to an endangered forest specialist, the Spotted Ground Thrush (*Zoothera guttata*). Forest Ecology and Management 400, 523-530.

105 Ehlers Smith, D.A., Ehlers Smith, Y.C., Downs, C.T., 2017b. Seasonal habitat requirements of Lemon Dove (*Aplopelia larvata*) in coastal forest: camera-trap surveys of a reclusive species. African Zoology 52, 199-207.

106 Ehlers Smith, Y.C., Ehlers Smith, D.A., Ramesh, T., Downs, C.T., 2017c. The importance of microhabitat structure in maintaining forest mammal diversity in a mixed land-use mosaic. Biodiversity and Conservation 26, 2361-2382.

107 Ehlers Smith, Y.C., Ehlers Smith, D.A., Ramesh, T., Downs, C.T., 2018. Forest habitats in a mixed urban-agriculture mosaic landscape: patterns of mammal occupancy. Landscape Ecology 33, 59-76.

108 Ehlers Smith, Y.C., Ehlers Smith, D.A., Ramesh, T., Downs, C.T., 2019. Novel predators and anthropogenic disturbance influence spatio-temporal distribution of forest antelope species. Behavioural Processes 159, 9-22.

109 Ehlers Smith, Y.C., Ehlers Smith, D.A., Ramesh, T., Downs, C.T., 2020a. Co-occurrence modelling highlights conservation implications for two competing spiral-horned antelope. Austral Ecology 45, 305-318.

110 Ehlers Smith, Y.C., Ehlers Smith, D.A., Ramesh, T., Downs, C.T., 2020b. Landscape-scale drivers of mammalian species richness and functional diversity in forest patches within a mixed land-use mosaic. Ecological Indicators 113, 106176.

111 Elkan, P.W., Parnell, R., Smith, J.D., 2009. A die-off of large ungulates following a *Stomoxys* biting fly out-break in lowland forest, northern Republic of Congo. African Journal of Ecology 47, 528-536.

112 Emmet, R.L., Augustine, B.C., Abrahms, B., Rich, L.N., Gardner, B., 2021. A spatial capture–recapture model for group-living species. Ecology, e03576.

113 Engelbrecht, D., 2016. Galagos as avian nest predators in South Africa. Primates 57, 455-458.

114 Estienne, V., Mundry, R., Kühl, H.S., Boesch, C., 2017a. Exploitation of underground bee nests by three sympatric consumers in Loango National Park, Gabon. Biotropica 49, 101-109.

115 Estienne, V., Stephens, C., Boesch, C., 2017b. Extraction of honey from underground bee nests by central African chimpanzees (*Pan troglodytes troglodytes*) in Loango National Park, Gabon: Techniques and individual differences. American Journal of Primatology 79, e22672.

116 Estienne, V., Robira, B., Mundry, R., Deschner, T., Boesch, C., 2019. Acquisition of a complex extractive technique by the immature chimpanzees of Loango National Park, Gabon. Animal Behaviour 147, 61-76.

117 Etana, B., Atickem, A., Tsegaye, D., Bekele, A., De Beenhouwer, M., Hundera, K., Lens, L., Fashing, P.J., Stenseth, N.C., 2021. Traditional shade coffee forest systems act as refuges for medium-and large-sized mammals as natural forest dwindles in Ethiopia. Biological Conservation 260, 109219.

118 Everatt, K.T., Andresen, L., Somers, M.J., 2015. The influence of prey, pastoralism and poaching on the hierarchical use of habitat by an apex predator. African Journal of Wildlife Research 45, 187-196.

119 Evrard, Q., Hardy, O.J., Tagg, N., Doucet, J.L., 2019. Removal and predation of aril-covered seeds: the case of *Afzelia bipindensis* (Fabaceae–Detarioidae). Plant Ecology and Evolution 152, 460-469.

120 Fabiano, E.C., Sutherland, C., Fuller, A.K., Nghikembua, M., Eizirik, E., Marker, L., 2020. Trends in cheetah *Acinonyx jubatus* density in north-central Namibia. Population Ecology 62, 233-243.

121 Farris, Z.J., Karpanty, S.M., Ratelolahy, F., Kelly, M.J., 2014. Predator–primate distribution, activity, and co-occurrence in relation to habitat and human activity across fragmented and contiguous forests in northeastern Madagascar. International Journal of Primatology 35, 859-880.

122 Farris, Z.J., Boone, H.M., Karpanty, S., Murphy, A., Ratelolahy, F., Andrianjakarivelo, V., Kelly, M.J., 2016a. Feral cats and the *fitoaty*: first population assessment of the black forest cat in Madagascar's rainforests. Journal of Mammalogy 97, 518-525.

123 Farris, Z.J., Kelly, M.J., Karpanty, S., Ratelolahy, F., 2016b. Patterns of spatial co-occurrence among native and exotic carnivores in north-eastern Madagascar. Animal Conservation 19, 189-198.

124 Farris, Z.J., Kelly, M.J., Karpanty, S., Murphy, A., Ratelolahy, F., Andrianjakarivelo, V., Holmes, C., 2017. The times they are a changin': Multi-year surveys reveal exotics replace native carnivores at a Madagascar rainforest site. Biological Conservation 206, 320-328.

125 Faure, J.P.B., Swanepoel, L.H., Cilliers, D., Venter, J. A., Hill, R.A., 2021. Estimates of carnivore densities in a human-dominated agricultural matrix in South Africa. Oryx 1-8.

126 Fink, S., Chandler, R., Chamberlain, M., Castleberry, S., Glosenger-Thrasher, S., 2020. Distribution and activity patterns of large carnivores and their implications for human–carnivore conflict management in Namibia. Human–Wildlife Interactions 14, 287-295.

127 Fležar, U., Le Roux, E., Kerley, G.I., Kuijper, D.P., te Beest, M., Druce, D.J., Prinsloo, D., Cromsigt, J.P., 2019. Simulated elephant-induced habitat changes can create dynamic landscapes of fear. Biological Conservation 237, 267-279.

128 Fonteyn, D., Vermeulen, C., Deflandre, N., Cornelis, D., Lhoest, S., Houngbégnon, F.G.A., Doucet, J.L., Fayolle, A., 2021. Wildlife trail or systematic? Camera trap placement has little effect on estimates of mammal diversity in a tropical forest in Gabon. Remote Sensing in Ecology and Conservation 7, 321-336.

129 Fotang, C., Bröring, U., Roos, C., Enoguanbhor, E.C., Abwe, E.E., Dutton, P., Schierack, P., Angwafo, T.E., Birkhofer, K., 2021. Human activity and forest degradation threaten populations of the Nigeria–Cameroon chimpanzee (*Pan troglodytes ellioti*) in Western Cameroon. International Journal of Primatology 42, 105-129.

130 Freeman, E.W., Meyer, J.M., Adendorff, J., Schulte, B.A., Santymire, R.M., 2014. Scraping behavior of black rhinoceros is related to age and fecal gonadal metabolite concentrations. Journal of Mammalogy 95, 340-348.

131 Fuda, R.K., Ryan, S.J., Cohen, J.B., Hartter, J., Frair, J.L., 2018. Assessing the impacts of oil exploration and restoration on mammals in Murchison Falls Conservation Area, Uganda. African Journal of Ecology 56, 804-817.

132 Garriga, R.M., Marco, I., Casas-Díaz, E., Acevedo, P., Amarasekaran, B., Cuadrado, L., Humle, T., 2019. Factors influencing wild chimpanzee (*Pan troglodytes verus*) relative abundance in an agriculture-swamp matrix outside protected areas. PLoS ONE 14, e0215545.

133 Gaugris, J., Niemand, L., Thomas, A., Orban, B., Morley, R., Melville, H., Drescher, K., Gaugris, C.A.V., 2021. A snapshot camera trap assessment of mammals in Congo's Massif du Chaillu with a noteworthy record of grey-necked rockfowl *Picathartes oreas*. African Journal of Ecology 59, 749-754.

134 Gaynor, K.M., Branco, P.S., Long, R.A., Gonçalves, D.D., Granli, P.K., Poole, J.H., 2018. Effects of human settlement and roads on diel activity patterns of elephants (*Loxodonta africana*). African Journal of Ecology 56, 872-881.

135 Gaynor, K.M., Daskin, J.H., Rich, L.N., Brashares, J.S., 2021. Postwar wildlife recovery in an African savanna: evaluating patterns and drivers of species occupancy and richness. Animal Conservation 24, 510-522.

136 Gebert, F., Njovu, H.K., Treydte, A.C., Steffan-Dewenter, I., Peters, M.K., 2019. Primary productivity and habitat protection predict elevational species richness and community biomass of large mammals on Mt. Kilimanjaro. Journal of Animal Ecology 88, 1860-1872.

137 Gebert, F., Steffan-Dewenter, I., Moretto, P., Peters, M.K., 2020. Climate rather than dung resources predict dung beetle abundance and diversity along elevational and land use gradients on Mt. Kilimanjaro. Journal of Biogeography 47, 371-381.

138 Gerber, B., Karpanty, S.M., Crawford, C., Kotschwar, M., Randrianantenaina, J., 2010. An assessment of carnivore relative abundance and density in the eastern rainforests of Madagascar using remotely-triggered camera traps. Oryx 44, 219-222.

139 Gerber, B.D., Karpanty, S.M., Randrianantenaina, J., 2012. The impact of forest logging and fragmentation on carnivore species composition, density and occupancy in Madagascar's rainforests. Oryx 46, 414-422.

140 Gessner, J., Buchwald, R., Wittemyer, G., 2014. Assessing species occurrence and species-specific use patterns of bais (forest clearings) in Central Africa with camera traps. African Journal of Ecology 52, 59-68.

141 Gil-Sánchez, J.M., Herrera-Sánchez, F.J., Rodríguez-Siles, J., Sáez, J.M., Díaz-Portero, M.Á., Arredondo, Á., Álvarez, B., Cancio, I., de Lucas, J., Castillo, S., McCain, E., Pérez, J., Valenzuela, G., Valderrama, J.M., Bautista, J., Sarabia, C., Leonard, J., Sánchez-Cerdá, M., Virgós, E., Qninba, A., 2020. Feeding Specialization of Honey Badgers in the Sahara Desert: A Trial of Life in a Hard Environment. Diversity 12, 59.

142 Gil-Sánchez, J.M., Mañá-Varela, B., Herrera-Sánchez, F.J., Urios, V., 2021. Spatio-temporal ecology of a carnivore community in middle atlas, NW of Morocco. Zoology 146, 125904.

143 Giordano, A.J., Tumenta, P.N., de Iongh, H.H., 2017. Camera-trapping confirms unheralded disappearance of the leopard (*Panthera pardus*) from Waza National Park, Cameroon. African Journal of Ecology 55, 722-726.

144 Greco, I., Rovero, F., 2021. The African golden cat *Caracal aurata* in Tanzania: first record and vulnerability assessment. Oryx 55, 212-215.

145 Greco, I., Chizzola, M., Meloro, C., Swanepoel, L., Tamagnini, D., Dalerum, F., 2021. Similarities between lions and sympatric carnivores in diel activity, size and morphology. Hystrix, the Italian Journal of Mammalogy 32, 122-129.

146 Green, S.E., Davidson, Z., Kaaria, T., Doncaster, C.P., 2018. Do wildlife corridors link or extend habitat? Insights from elephant use of a Kenyan wildlife corridor. African Journal of Ecology 56, 860-871.

147 Grey, J.N.C., Kent, V.T., Hill, R.A., 2013. Evidence of a high density population of harvested leopards in a montane environment. PLoS ONE 8, e82832.

148 Gueye, M., Brandlová, K., Rabeil, T., Diop, M.M., Diop, B., Hejcmanová, P., 2021. Spatially restricted occurrence and low abundance as key tools for conservation of critically endangered large antelope in West African savannah. Scientific Reports 11, 19397.

149 Gumede, S., Ehlers Smith, D., Ehlers Smith, Y., Ngcobo, S., Sosibo, M., Maseko, M., Downs, C., 2020. Occupancy of two forest specialist birds in the southern mistbelt forests of KwaZulu-Natal and Eastern Cape, South Africa. Bird Conservation International, 1-16.

150 Hanekom, N., Randall, R.M., 2015. Assessments of occurrence and distribution of mammals in forests of the Garden Route National Park based on camera trapping. Koedoe 57, 1257.

151 Hanke, P.U., Dickman, C.R., 2013. Sniffing out the stakes: hair-snares for wild cats in arid environments. Wildlife Research 40, 45-51.

152 Hardouin, M., Searle, C.E., Strampelli, P., Smit, J., Dickman, A., Lobora, A.L., Rowcliffe, J.M., 2021. Density responses of lesser-studied carnivores to habitat and management strategies in southern Tanzania's Ruaha-Rungwa landscape. PLoS One 16, e0242293.

153 Hart, L.A., Downs, C.T., Brown, M., 2016. Sitting in the sun: Nest microhabitat affects incubation temperatures in seabirds. Journal of Thermal Biology 60, 149-154.

154 Haurez, B., Daïnou, K., Tagg, N., Petre, C.A., Doucet, J.L., 2015. The role of great apes in seed dispersal of the tropical forest tree species *Dacryodes normandii* (Burseraceae) in Gabon. Journal of Tropical Ecology 31, 395-402.

155 Hausser, Y., Tagand, R., Vimercati, E., Mermod, S., Fischer, C., 2017. Comparing survey methods to assess the conservation value of a community-managed protected area in western Tanzania. African Journal of Ecology 55, 1-11.

156 Havmøller, R.W., Tenan, S., Scharff, N., Rovero, F., 2019. Reserve size and anthropogenic disturbance affect the density of an African leopard (*Panthera pardus*) meta-population. PLoS ONE 14, e0209541.

157 Havmøller, R.W., Jacobsen, N.S., Scharff, N., Rovero, F., Zimmermann, F., 2020. Assessing the activity pattern overlap among leopards (*Panthera pardus*), potential prey and competitors in a complex landscape in Tanzania. Journal of Zoology 311, 175-182.

158 Hayward, M.W., Hayward, M.D., 2012. Waterhole use by African fauna. African Journal of Wildlife Research 42, 117-127.

159 Head, J.S., Robbins, M.M., Mundry, R., Makaga, L., Boesch, C., 2012. Remote video-camera traps measure habitat use and competitive exclusion among sympatric chimpanzee, gorilla and elephant in Loango National Park, Gabon. Journal of Tropical Ecology 28, 571-583.

160 Head, J.S., Boesch, C., Robbins, M.M., Rabanal, L.I., Makaga, L., Kühl, H.S., 2013. Effective sociodemographic population assessment of elusive species in ecology and conservation management. Ecology and Evolution 3, 2903-2916.

161 Hedwig, D., Kienast, I., Bonnet, M., Curran, B.K., Courage, A., Boesch, C., Kuhl, H.S., King, T., 2018. A camera trap assessment of the forest mammal community within the transitional savannah-forest mosaic of the Batéké Plateau National Park, Gabon. African Journal of Ecology 56, 777-790.

162 Hegerl, C., Burgess, N.D., Nielsen, M.R., Martin, E., Ciolli, M., Rovero, F., 2017. Using camera trap data to assess the impact of bushmeat hunting on forest mammals in Tanzania. Oryx 51, 87-97.

163 Henschel, P., Hunter, L.T., Coad, L., Abernethy, K.A., Mühlenberg, M., 2011. Leopard prey choice in the Congo Basin rainforest suggests exploitative competition with human bushmeat hunters. Journal of Zoology 285, 11-20.

164 Henschel, P., Malanda, G.A., Hunter, L., 2014. The status of savanna carnivores in the Odzala-Kokoua National Park, northern Republic of Congo. Journal of Mammalogy 95, 882-892.

165 Hobbhahn, N., Johnson, S.D., 2015. Sunbird pollination of the dioecious root parasite *Cytinus sanguineus* (Cytinaceae). South African Journal of Botany 99, 138-143.

166 Holdo, R.M., Onderdonk, D.A., Barr, A.G., Mwita, M., Anderson, T.M., 2020. Spatial transitions in tree cover are associated with soil hydrology, but not with grass biomass, fire frequency, or herbivore biomass in Serengeti savannahs. Journal of Ecology 108, 586-597.

167 Hongo, S., Nakashima, Y., Akomo-Okoue, E.F., Mindonga-Nguelet, F.L., 2016. Female reproductive seasonality and male influxes in wild mandrills (*Mandrillus sphinx*). International Journal of Primatology 37, 416-437.

168 Hongo, S., Nakashima, Y., Akomo-Okoue, E.F., Mindonga-Nguelet, F.L., 2018. Seasonal Change in Diet and Habitat Use in Wild Mandrills (*Mandrillus sphinx*). International Journal of Primatology 39, 27-48.

169 Houngbégnon, F.G., Cornelis, D., Vermeulen, C., Sonké, B., Ntie, S., Fayolle, A., Fonteyn, D., Lhoest, S., Evrard, Q., Yapi, F., Sandrin, F., Vanegas, L., Ayaya, I., Hardy, C., Le Bel, S., Doucet, J.L., 2020. Daily activity patterns and co-occurrence of duikers revealed by an intensive camera trap survey across central African rainforests. Animals 10, 2200.

170 Howes-Whitecross, M.A., Howes, C., Colyn, R.B., Smit-Robinson, H.A., 2020. Challenges in nest monitoring of White-winged Flufftails *Sarothrura ayersi* in Ethiopia. Ostrich 91, 260-263.

171 Isbell, L.A., Bidner, L.R., 2016. Vervet monkey (*Chlorocebus pygerythrus*) alarm calls to leopards (*Panthera pardus*) function as a predator deterrent. Behaviour 153, 591-606.

172 Isbell, L.A., Bidner, L.R., Crofoot, M.C., Matsumoto-Oda, A., Farine, D.R., 2017. GPS-identified, low-level nocturnal activity of vervets (Chlorocebus pygerythrus) and olive baboons (Papio anubis) in Laikipia, Kenya. American Journal of Physical Anthropology 164, 203-211.

173 Janecke, B.B., 2021. Mammal species richness at a catena and nearby waterholes during a drought, Kruger National Park, South Africa. Diversity 13, 387.

174 John Power, R., Rogan, M.S., Naude, V.N., 2021. Mountain refugia limit anthropogenic suppression in a re-established felid population: the case of the Magaliesberg leopard population in South Africa. African Zoology 56, 292-302.

175 Johnson, S.D., Van der Niet, T., 2019. Bird pollination in an African *Satyrium* (Orchidaceae) confirmed by camera traps and selective exclusion experiments. Plant Systematics and Evolution 305, 477-484.

176 Jooste, E., Hayward, M.W., Pitman, R.T., Swanepoel, L.H., 2013. Effect of prey mass and selection on predator carrying capacity estimates. European Journal of Wildlife Research 59, 487-494.

177 Jůnek, T., Vymyslická, P.J., Hozdecká, K., Hejcmanová, P., 2015. Application of spatial and closed capture-recapture models on known population of the Western Derby eland (*Taurotragus derbianus derbianus*) in Senegal. PLoS ONE 10, e0136525.

178 Kane, M.D., Morin, D.J., Kelly, M.J., 2015. Potential for camera-traps and spatial mark-resight models to improve monitoring of the critically endangered West African lion (*Panthera leo*). Biodiversity and Conservation 24, 3527-3541.

179 Karssene, Y., Godinho, R., Chammem, M., Cocchiararo, B., Nouira, S., Nowak, C., 2019a. Noninvasive DNA sampling and camera trapping suggest dramatic regional conservation status of an understudied carnivore: the Rüppell's fox in Tunisia. Journal of Natural History 53, 1439-1449.

180 Karssene, Y., Chammem, M., Li, F., Eddine, A., Hermann, A., Nouira, S., 2019b. Spatial and temporal variability in the distribution, daily activity and diet of fennec fox (*Vulpes zerda*), red fox (*Vulpes vulpes*) and African golden wolf (*Caniss anthus*) in southern Tunisia. Mammalian Biology 95, 41-50.

181 Kauffman, M.J., Sanjayan, M., Lowenstein, J., Nelson, A., Jeo, R.M., Crooks, K.R., 2007. Remote camera-trap methods and analyses reveal impacts of rangeland management on Namibian carnivore communities. Oryx 41, 70-78.

182 Kavwele, C.M., Kimanzi, J.K., Kinyanjui, M.J., 2017. Impacts of bush encroachment on wildlife species diversity, composition, and habitat preference in Ol Pejeta Conservancy, Laikipia, Kenya. International Journal of Ecology 2017, 5620125.

183 Kely, M.R., Kouakou, C.Y., Béné, J.C.K., Tiedoué, M.R., Diarrasouba, A., Tondossama, A., Kuehl, H.S., Waltert, M., 2021. Research and tourism affect positively the occupancy pattern of *Loxodonta cyclotis* (elephantidae) in Taï National Park, Côte d'Ivoire. Nature Conservation Research 6.

184 Kent, V.T., Hill, R.A., 2013. The importance of farmland for the conservation of the brown hyaena *Parahyaena brunnea*. Oryx 47, 431-440.

185 Kheswa, E.Z., Ramesh, T., Kalle, R., Downs, C.T., 2018. Habitat use by honey badgers and the influence of predators in iSimangaliso Wetland Park, South Africa. Mammalian Biology 90, 22-29.

186 Kiepiel, I., Johnson, S.D., 2019. Spit it out: Monkeys disperse the unorthodox and toxic seeds of *Clivia miniata* (Amaryllidaceae). Biotropica 51, 619-625.

187 Kinnaird, M.F., O'Brien, T.G., 2012. Effects of private-land use, livestock management, and human tolerance on diversity, distribution, and abundance of large African mammals. Conservation Biology 26, 1026-1039.

188 Koeppel, K.N., Kuhn, B.F., Thompson, P.N., 2020. Oral bait preferences for rabies vaccination in free-ranging black-backed jackal (*Canis mesomelas*) and non-target species in a multi-site field study in a peri-urban protected area in South Africa. Preventive Veterinary Medicine 175, 104867.

189 Koopmans, M., Stokes, E.J., Opepa, C.K., Mouele, A.M., Abea, G., Strindberg, S., Brncic, T.M., 2021. Wild bongo density estimation and population viability analysis improves conservation management. Global Ecology and Conservation 28, e01661.

190 Kühn, N., Midgley, J., Steenhuisen, S.L., 2017. Reproductive biology of three co-occurring, primarily small-mammal pollinated *Protea* species (Proteaceae). South African Journal of Botany 113, 337-345.

191 Lacroux, C., Guma, N., Krief, S., 2019. Facial dysplasia in wild forest olive baboons *(Papio anubis*) in Sebitoli, Kibale National Park, Uganda: Use of camera traps to detect health defects. Journal of Medical Primatology 48, 143-153.

192 LaFleur, M., Sauther, M., Cuozzo, F., Yamashita, N., Youssouf, I.A.J., Bender, R., 2014. Cathemerality in wild ring-tailed lemurs (*Lemur catta*) in the spiny forest of Tsimanampetsotsa National Park: camera trap data and preliminary behavioral observations. Primates 55, 207-217.

193 Laguardia, A., Gobush, K.S., Bourgeois, S., Strindberg, S., Abitsi, G., Ebouta, F., Fay, J.M., Gopalaswamy, A.M., Maisels, F., Ogden, R., White, L.J.T., Stokes, E.J., 2021. Assessing the feasibility of density estimation methodologies for African forest elephant at large spatial scales. Global Ecology and Conservation 27, e01550.

194 Lapuente, J., Hicks, T.C., Linsenmair, K.E., 2017. Fluid dipping technology of chimpanzees in Comoé National Park, Ivory Coast. American Journal of Primatology 79, e22628.

195 Lapuente, J., Arandjelovic, M., Kühl, H., Dieguez, P., Boesch, C., Linsenmair, K.E., 2020a. Sustainable peeling of kapok tree (*Ceiba pentandra*) bark by the chimpanzees (*Pan troglodytes verus*) of Comoé National Park, Ivory Coast. International Journal of Primatology, 1-27.

196 Lapuente, J., Ouattara, A., Köster, P.C., Linsenmair, K.E., 2020b. Status and distribution of Comoé Chimpanzees: combined use of transects and camera traps to quantify a low-density population in savanna-forest mosaic. Primates, 1-13.

197 Laudisoit, A., Huyghe, P., Willie, J., Ndjoku, B., Scholier, T., Dz'na, J., Tagg, N., Maher, S., Mande, C., Hoda, T., Hicks, T.C., Baelo, P., Kpanyogo, O., Ngbathe, G.N., Gembu, G.C., Omatoko, J., Anio, J.A., Leirs, H., Verheyen, E., 2021. Chimpanzees surviving in a fragmented high-altitude forest landscape of the Congolese Albertine Rift. Conservation Science and Practice 3, e403.

198 Lhoest, S., Fonteyn, D., Daïnou, K., Delbeke, L., Doucet, J. L., Dufrêne, M., Josso, J.F., Ligot, G., Oszwald, J., Rivault, E., Verheggen, F., Vermeulen, C., Biwolé, A., Fayolle, A., 2020. Conservation value of tropical forests: Distance to human settlements matters more than management in Central Africa. Biological Conservation 241, 108351.

199 Lombardi, G.C., Peter, C.I., Turner, R.C., Midgley, J.J., 2017. The unusual, closed flowers of *Erica lanuginosa* (Ericaceae) are adapted for rodent-pollination and not cleistogamy. South African Journal of Botany 111, 189-193.

200 Loock, D.J., Williams, S.T., Emslie, K.W., Matthews, W.S., Swanepoel, L.H., 2018. High carnivore population density highlights the conservation value of industrialised sites. Scientific Reports 8, 1-9.

201 Loveridge, A.J., Sousa, L.L., Seymour-Smith, J., Hunt, J., Coals, P., O'Donnell, H., Lindsey, P.A., Mandisodza-Chikerema, R., Macdonald, D.W., 2020. Evaluating the spatial intensity and demographic impacts of wire-snare bush-meat poaching on large carnivores. Biological Conservation 244, 108504.

202 Majelantle, T.L., Ganswindt, A., Jordaan, R.K., Slip, D.J., Harcourt, R., McIntyre, T., 2021. Increased population density and behavioural flexibility of African clawless otters (*Aonyx capensis*) in specific anthropogenic environments. Urban Ecosystems 24, 691-699.

203 Mann, G.K., Lagesse, J.V., O'Riain, M.J., Parker, D.M., 2015. Beefing up species richness? The effect of land-use on mammal diversity in an arid biodiversity hotspot. African Journal of Wildlife Research 45, 321-331.

204 Mann, G.K., Wilkinson, A., Hayward, J., Drouilly, M., O'Riain, M.J., Parker, D.M., 2019. The effects of aridity on land use, biodiversity and dietary breadth in leopards. Mammalian Biology 98, 43-51.

205 Mann, G.K., O'Riain, M.J., Parker, D M., 2020. A leopard's favourite spots: habitat preference and population density of leopards in a semi-arid biodiversity hotspot. Journal of Arid Environments 181, 104218.

206 Mapendere, C., Jori, F., Etter, E.M., Ferguson, J.H.W., 2021. Do wild suids from Ndumo Game Reserve, South Africa, play a role in the maintenance and transmission of African Swine Fever to domestic pigs? Transboundary and Emerging Diseases 68, 2774-2786.

207 Maphalala, M.I., Monadjem, A., 2017. White-backed Vulture *Gyps africanus* parental care and chick growth rates assessed by camera traps and morphometric measurements. Ostrich 88, 123-129.

208 Maputla, N.W., Chimimba, C.T., Ferreira, S.M., 2013. Calibrating a camera trap–based biased mark–recapture sampling design to survey the leopard population in the N'wanetsi concession, Kruger National Park, South Africa. African Journal of Ecology 51, 422-430.

209 Marnewick, K.A., Bothma, J.D.P., Verdoorn, G.H., 2006. Using camera-trapping to investigate the use of a tree as a scent-marking post by cheetahs in the Thabazimbi district. South African Journal of Wildlife Research 36, 139-145.

210 Marnewick, K., Funston, P.J., Karanth, K.U., 2008. Evaluating camera trapping as a method for estimating cheetah abundance in ranching areas. South African Journal of Wildlife Research 38, 59-65.

211 Marrocoli, S., Nielsen, M.R., Morgan, D., van Loon, T., Kulik, L., Kühl, H., 2019. Using wildlife indicators to facilitate wildlife monitoring in hunter-self monitoring schemes. Ecological Indicators 105, 254-263.

212 Martin, E.H., Cavada, N., Ndibalema, V.G., Rovero, F., 2015. Modelling fine-scale habitat associations of medium-to-large forest mammals in the Udzungwa Mountains of Tanzania using camera trapping. Tropical Zoology 28, 137-151.

213 Martin, E.H., Ndibalema, V.G., Rovero, F., 2017. Does variation between dry and wet seasons affect tropical forest mammals' occupancy and detectability by camera traps? Case study from the Udzungwa Mountains, Tanzania. African Journal of Ecology 55, 37-46.

214 Martínez-Íñigo, L., Baas, P., Klein, H., Pika, S., Deschner, T., 2021. Intercommunity interactions and killings in central chimpanzees (*Pan troglodytes troglodytes*) from Loango National Park, Gabon. Primates 62, 709-722.

215 Martins, Q., Harris, S., 2013. Movement, activity and hunting behaviour of leopards in the Cederberg mountains, South Africa. African Journal of Ecology 51, 571-579.

216 Maseko, M.S., Ramesh, T., Kalle, R., Downs, C.T., 2017. Response of Crested Guinea-fowl (*Guttera edouardi*), a forest specialist, to spatial variation in land use in iSimangaliso wetland Park, South Africa. Journal of Ornithology 158, 469-477.

217 Masiaine, S., Pilfold, N., Moll, R.J., O'connor, D., Larpei, L., Stacy-Dawes, J., Ruppert, K., Glikman, J.A., Roloff, G., Montgomery, R.A., 2021. Landscape-level changes to large mammal space use in response to a pastoralist incursion. Ecological Indicators 121, 107091.

218 Mateo-Tomás, P., Olea, P.P., Moleón, M., Selva, N., Sánchez-Zapata, J.A., 2017. Both rare and common species support ecosystem services in scavenger communities. Global Ecology and Biogeography 26, 1459-1470.

219 Mayengo, G., Armbruster, W., Treydte, A.C., 2020. Quantifying nutrient re-distribution from nutrient hotspots using camera traps, indirect observation and stable isotopes in a miombo ecosystem, Tanzania. Global Ecology and Conservation 23, e01073.

220 McCarthy, M.S., Stephens, C., Dieguez, P., Samuni, L., Després-Einspenner, M.L., Harder, B., Landsmann, A., Lynn, L.K., Maldonado, N., Ročkaiová, Z., Widness, J., Wittig, R.M., Boesch, C., Kühl, H.S., Arandjelovic, M., 2021. Chimpanzee identification and social network construction through an online citizen science platform. Ecology and Evolution 11, 1598-1608.

221 McCollum, K.R., Conway, A.L., Lee, M.B., Carroll, J.P., 2017. Occupancy and demographics of red river hog *Potamochoerus porcus* on Tiwai Island, Sierra Leone. African Journal of Ecology 55, 47-55.

222 McCollum, K.R., Belinfonte, E., Conway, A.L., Carroll, J.P., 2018. Occupancy and habitat use by six species of forest ungulates on Tiwai Island, Sierra Leone. Koedoe 60, 1-5.

223 McPherson, S.C., Brown, M., Downs, C.T., 2016. Diet of the crowned eagle (*Stephanoaetus coronatus*) in an urban landscape: potential for human-wildlife conflict? Urban Ecosystems 19, 383-396.

224 Merson, S.D., Dollar, L.J., Tan, C.K.W., Macdonald, D.W., 2019. Activity patterns of sympatric living exotic and endemic carnivores (the fosa) in Western Madagascar's deciduous forests. Journal of Zoology 307, 186-194.

225 Merson, S.D., Dollar, L.J., Tan, C.K.W., Macdonald, D.W., 2020. Effects of habitat alteration and disturbance by humans and exotic species on fosa *Cryptoprocta ferox* occupancy in Madagascar's deciduous forests. Oryx 54, 828-836.

226 Mertens, J.E.J., Emsens, W.J., Jocqué, M., Geeraert, L., De Beenhouwer, M., 2020. From natural forest to coffee agroforest: implications for communities of large mammals in the Ethiopian highlands. Oryx 54, 715-722.

227 Mhlanga, M., Ramesh, T., Kalle, R., Madiri, T.H., Downs, C.T., 2018. Spotted hyaena (*Crocuta crocuta*) habitat occupancy in a national park, hunting area and private ranch in western Zimbabwe. African Journal of Ecology 56, 818-827.

228 Miller, J.R., Pitman, R.T., Mann, G.K., Fuller, A.K., Balme, G.A., 2018. Lions and leopards coexist without spatial, temporal or demographic effects of interspecific competition. Journal of Animal Ecology 87, 1709-1726.

229 Mills, K.L., Harris, N.C., 2020. Humans disrupt access to prey for large African carnivores. Elife 9, e60690.

230 Mills, D., Fattebert, J., Hunter, L., Slotow, R., 2019a. Maximising camera trap data: Using attractants to improve detection of elusive species in multi-species surveys. PLoS ONE 14, e0216447.

231 Mills, D.R., Do Linh San, E., Robinson, H., Isoke, S., Slotow, R., Hunter, L., 2019b. Competition and specialization in an African forest carnivore community. Ecology and Evolution 9, 10092-10108.

232 Mills, K.L., Harissou, Y., Gnoumou, I.T., Abdel-Nasser, Y.I., Doamba, B., Harris, N.C., 2020. Comparable space use by lions between hunting concessions and national parks in West Africa. Journal of Applied Ecology 57, 975-984.

233 Mokotjomela, T.M., Hoffmann, J.H., 2013. Removal of post-dispersed seeds in *Acacia cyclops* thickets under biological control in South Africa. South African Journal of Botany 88, 260-264.

234 Monterroso, P., Rocha, F., van Wyk, S., António, T., Chicomo, M., Kosmas, S., Lages, F., Fabiano, E., Godinho, R., 2020. Updated ranges of the vulnerable cheetah and endangered African wild dog in Angola. Oryx 54, 851-853.

235 Moolman, L., de Morney, M.A., Ferreira, S.M., Ganswindt, A., Poole, J.H., Kerley, G.I., 2019. And then there was one: a camera trap survey of the declining population of African Elephants in Knysna, South Africa. African Journal of Wildlife Research 49, 16-26.

236 Moore, J.F., Pine, W.E., Mulindahabi, F., Niyigaba, P., Gatorano, G., Masozera, M.K., Beaudrot, L., 2020. Comparison of species richness and detection between line transects, ground camera traps, and arboreal camera traps. Animal Conservation 23, 561-572.

237 Morris, D.R., Boardman, W.S., Swanepoel, L.H., Simpson, G., Coetzee, J., Camacho, G.J., McWhorter, T.J., 2021. Population density estimate of leopards (Panthera pardus) in north-western Mpumalanga, South Africa, determined using spatially explicit capture–recapture methods. Mammalian Biology.

238 Morrison, R.E., Dunn, J.C., Illera, G., Walsh, P.D., Bermejo, M., 2020. Western gorilla space use suggests territoriality. Scientific Reports 10, 3692.

239 Moupela, C., Doucet, J.L., Daïnou, K., Tagg, N., Bourland, N., Vermeulen, C., 2014. Dispersal and predation of diaspores of *Coula edulis* Baill. in an evergreen forest of Gabon. African Journal of Ecology 52, 88-96.

240 Msuha, M.J., Carbone, C., Pettorelli, N., Durant, S.M., 2012. Conserving biodiversity in a changing world: land use change and species richness in northern Tanzania. Biodiversity and Conservation 21, 2747-2759.

241 Mugerwa, B., Sheil, D., Ssekiranda, P., van Heist, M., Ezuma, P., 2013. A camera trap assessment of terrestrial vertebrates in Bwindi Impenetrable National Park, Uganda. African Journal of Ecology 51, 21-31.

242 Mugerwa, B., du Preez, B., Tallents, L.A., Loveridge, A.J., Macdonald, D.W., 2017. Increased foraging success or competitor avoidance? Diel activity of sympatric large carnivores. Journal of Mammalogy 98, 1443-1452.

243 Muneza, A.B., Ortiz-Calo, W., Packer, C., Cusack, J.J., Jones, T., Palmer, M.S., Swanson, A., Kosmala, M., Dickman, A.J., Macdonald, D.W., Montgomery, R.A., 2019. Quantifying the severity of giraffe skin disease via photogrammetry analysis of camera trap data. Journal of Wildlife Diseases 55, 770-781.

244 Murphy, A.J., Goodman, S.M., Farris, Z.J., Karpanty, S.M., Andrianjakarivelo, V., Kelly, M.J., 2017. Landscape trends in small mammal occupancy in the Makira–Masoala protected areas, northeastern Madagascar. Journal of Mammalogy 98, 272-282.

245 Murphy, A., Gerber, B.D., Farris, Z.J., Karpanty, S., Ratelolahy, F., Kelly, M.J., 2018a. Making the most of sparse data to estimate density of a rare and threatened species: a case study with the fosa, a little-studied Malagasy carnivore. Animal Conservation 21, 496-504.

246 Murphy, A.J., Farris, Z.J., Karpanty, S., Kelly, M.J., Miles, K.A., Ratelolahy, F., Rahariniaina, R.P., Golden, C.D., 2018b. Using camera traps to examine distribution and occupancy trends of ground-dwelling rainforest birds in north-eastern Madagascar. Bird Conservation International 28, 567-580.

247 Murphy, A., Kelly, M.J., Karpanty, S.M., Andrianjakarivelo, V., Farris, Z.J., 2019. Using camera traps to investigate spatial co-occurrence between exotic predators and native prey species: a case study from northeastern Madagascar. Journal of Zoology 307, 264-273.

248 Nakashima, Y., 2015. Inventorying medium-and large-sized mammals in the African lowland rainforest using camera trapping. Tropics 23, 151-164.

249 Nakashima, Y., Iwata, Y., Ando, C., Nze Nkoguee, C., Inoue, E., Okoue Akomo, E.F., Nguema, P.M., Bineni, T.D., Banak, L.N., Takenoshita, Y., Ngomanda, A., Yamagiwa, J., 2013. Assessment of landscape-scale distribution of sympatric great apes in African rainforests: concurrent use of nest and camera-trap surveys. American Journal of Primatology 75, 1220-1230.

250 Nakashima, Y., Hongo, S., Akomo-Okoue, E.F., 2020. Landscape-scale estimation of forest ungulate density and biomass using camera traps: applying the REST model. Biological Conservation 241, 108381.

251 Ndlovu, M., Pérez-Rodríguez, A., Devereux, E., Thomas, M., Colina, A., Molaba, L., 2018. Water for African elephants (*Loxodonta africana*): faecal microbial loads affect use of artificial waterholes. Biology Letters 14, 20180360.

252 Ngama, S., Korte, L., Johnson, M., Vermeulen, C., Bindelle, J., 2018a. Camera traps to study the forest elephant's *(Loxodonta cyclotis*) response to chilli pepper repellent devices in Gamba, Gabon. Nature Conservation Research 3, 26-35.

253 Ngama, S., Korte, L., Johnson, M., Bindelle, J., Ndong, A.N., Vermeulen, C., 2018b. Using camera traps and digital video to investigate the impact of *Aethina tumida* pest on honey bee (*Apis mellifera adansonii*) reproduction and ability to keep away elephants (*Loxodonta africana cyclotis*) in Gamba, Gabon. Nature Conservation Research 3, 89-99.

254 Nghikembua, M.T., Marker, L.L., Brewer, B., Mehtätalo, L., Appiah, M., Pappinen, A., 2020. Response of wildlife to bush thinning on the north central freehold farmlands of Namibia. Forest Ecology and Management 473, 118330.

255 Niang, A., Ndiaye, P.I., 2021. A large mammal survey in Koyli Alpha Community Wildlife Reserve and its surroundings in the Great Green Wall extension area in Senegal. Journal of Threatened Taxa 13, 19223-19231.

256 Nichols, C.A., Alexander, K., 2018. Creeping in the night: what might ecologists be missing? PLoS ONE 13, e0198277.

257 Noack, J., Heyns, L., Rodenwoldt, D., Edwards, S., 2019. Leopard density estimation within an enclosed reserve, Namibia using spatially explicit capture-recapture models. Animals 9, 724.

258 Nyiramana, A., Mendoza, I., Kaplin, B.A., Forget, P.M., 2011. Evidence for seed dispersal by rodents in tropical montane forest in Africa. Biotropica 43, 654-657.

259 Oberosler, V., Tenan, S., Zipkin, E.F., Rovero, F., 2020a. Poor management in protected areas is associated with lowered tropical mammal diversity. Animal Conservation 23, 171-181.

260 Oberosler, V., Tenan, S., Zipkin, E.F., Rovero, F., 2020b. When parks work: effect of anthropogenic disturbance on occupancy of tropical forest mammals. Ecology and Evolution 10, 3881-3894.

261 O'Brien, T.G., Kinnaird, M.F., 2011. Density estimation of sympatric carnivores using spatially explicit capture–recapture methods and standard trapping grid. Ecological Applications 21, 2908-2916.

262 O'Brien, T.G., Ahumada, J., Akampurila, E., Beaudrot, L., Boekee, K., Brncic, T., Hickey, J., Jansen, P.A., Kayijamahe, C., Moore, J., Mugerwa, B., Mulindahabi, F., Ndoundou-Hockemba, M., Niyigaba, P., Nyiratuza, M., Opepa, C.K., Rovero, F., Uzabaho, E., Strindberg, S., 2020. Camera trapping reveals trends in forest duiker populations in African National Parks. Remote Sensing in Ecology and Conservation 6, 168-180.

263 Olson, E.R., Marsh, R.A., Bovard, B.N., Randrianarimanana, H.L., Ravaloharimanitra, M., Ratsimbazafy, J.H., King, T., 2012. Arboreal camera trapping for the critically endangered greater bamboo lemur *Prolemur simus*. Oryx 46, 593-597.

264 Omeja, P.A., Lawes, M.J., Corriveau, A., Valenta, K., Sarkar, D., Paim, F. P., Chapman, C.A., 2016. Recovery of tree and mammal communities during large-scale forest regeneration in Kibale National Park, Uganda. Biotropica 48, 770-779.

265 Orban, B., Kabafouako, G., Morley, R., Vasicek Gaugris, C., Melville, H., Gaugris, J., 2018. Common mammal species inventory utilizing camera trapping in the forests of Kouilou Département, Republic of Congo. African Journal of Ecology 56, 750-754.

266 Padayachee, K., Malan, G., LÜBCKER, N., Woodborne, S., Hall, G., 2021. Differences in the dietary habits of Verreaux's Eagles *Aquila verreauxii* between peri-urban and rural populations. Bird Conservation International 31, 96-110.

267 Page-Nicholson, S.K., Tate, G., Hoogstad, C., Murison, M., Diamond, M., Blofield, A., Pretorius, M., Michael, M.D., 2018. Mitigating the impact of large mammals on wooden electrical distribution poles in the Kruger National Park, South Africa. African Journal of Wildlife Research 48, 023006.

268 Palmer, M.S., Packer, C., 2018. Giraffe bed and breakfast: Camera traps reveal Tanzanian yellow-billed oxpeckers roosting on their large mammalian hosts. African Journal of Ecology 56, 882-884.

269 Patterson, L., Kalle, R., Downs, C., 2016. Predation of artificial bird nests in suburban gardens of KwaZulu-Natal, South Africa. Urban Ecosystems 19, 615-630.

270 Paúl, M.J., Layna, J.F., Monterroso, P., Álvares, F., 2020. Resource partitioning of sympatric African wolves (*Canis lupaster*) and side-striped Jackals (*Canis adustus*) in an arid environment from West Africa. Diversity 12, 477.

271 Payne, A., Ogweng, P., Ojok, A., Etter, E., Gilot-Fromont, E., Masembe, C., Ståhl, K., Jori, F., 2018. Comparison of three methods to assess the potential for bushpig-domestic pig interactions at the wildlife—livestock interface in Uganda. Frontiers in Veterinary Science 5, 295.

272 Payne, S.L., Witkowski, E.T., Symes, C.T., 2019. Good times, bad times: inter-annual reproductive output in a montane endemic succulent (*Aloe peglerae*; Asphodelaceae) driven by contrasting visitor responses of small mammals and birds. Australian Journal of Botany 67, 116-127.

273 Pebsworth, P.A., Bardi, M., Huffman, M.A., 2012. Geophagy in chacma baboons: patterns of soil consumption by age class, sex, and reproductive state. American Journal of Primatology 74, 48-57.

274 Pebsworth, P.A., Hillier, S., Wendler, R., Glahn, R., Ta, C.A.K., Arnason, J.T., Young, S.L., 2019. Geophagy among east African chimpanzees: consumed soils provide protection from plant secondary compounds and bioavailable iron. Environmental Geochemistry and Health 41, 2911-2927.

275 Pebsworth, P.A., Gruber, T., Miller, J.D., Zuberbühler, K., Young, S.L., 2020. Selecting between iron-rich and clay-rich soils: a geophagy field experiment with black-and-white colobus monkeys in the Budongo Forest Reserve, Uganda. Primates, 1-10.

276 Penny, S.G., White, R.L., Scott, D.M., MacTavish, L., Pernetta, A.P., 2021. No evidence that horn trimming affects white rhinoceros horn use during comfort behaviour and resource access. Animal Biology 71, 243-259.

277 Pettorelli, N., Lobora, A.L., Msuha, M.J., Foley, C., Durant, S.M., 2010. Carnivore biodiversity in Tanzania: revealing the distribution patterns of secretive mammals using camera traps. Animal Conservation 13, 131-139.

278 Pinto, P.V., Beja, P., Ferrand, N., Godinho, R., 2016. Hybridization following population collapse in a critically endangered antelope. Scientific Reports 6, 18788.

279 Pirie, T.J., Thomas, R.L., Fellowes, M.D., 2016. Erythristic leopards *Panthera pardus* in South Africa. Bothalia-African Biodiversity & Conservation 46, a2034.

280 Pozo, R.A., Coulson, T., McCulloch, G., Stronza, A., Songhurst, A., 2019. Chilli-briquettes modify the temporal behaviour of elephants, but not their numbers. Oryx 53, 100-108.

281 Puls, S., Teichman, K.J., Jansen, C., O'Riain, M.J., Cristescu, B., 2021. Activity patterns of leopards (*Panthera pardus*) and temporal overlap with their prey in an arid depredation hotspot of southern Africa. Journal of Arid Environments 187, 104430.

282 Ramesh, T., Downs, C.T., 2013. Impact of farmland use on population density and activity patterns of serval in South Africa. Journal of Mammalogy 94, 1460-1470.

283 Ramesh, T., Downs, C.T., 2014a. Modelling large spotted genet (*Genetta tigrina*) and slender mongoose (*Galerella sanguinea*) occupancy in a heterogeneous landscape of South Africa. Mammalian Biology 79, 331-337.

284 Ramesh, T., Downs, C.T., 2014b. Land use factors determining occurrence of Red-necked Spurfowl (*Pternistis afer*) in the Drakensberg Midlands, South Africa. Journal of Ornithology 155, 471-480.

285 Ramesh, T., Downs, C.T., 2015. Impact of land use on occupancy and abundance of terrestrial mammals in the Drakensberg Midlands, South Africa. Journal for Nature Conservation 23, 9-18.

286 Ramesh, T., Kalle, R., Downs, C.T., 2016a. Predictors of mammal species richness in KwaZulu-Natal, South Africa. Ecological Indicators 60, 385-393.

287 Ramesh, T., Kalle, R., Rosenlund, H., Downs, C.T., 2016b. Native habitat and protected area size matters: preserving mammalian assemblages in the Maputaland Conservation Unit of South Africa. Forest Ecology and Management 360, 20-29.

288 Ramesh, T., Kalle, R., Rosenlund, H., Downs, C.T., 2017a. Low leopard populations in protected areas of Maputaland: a consequence of poaching, habitat condition, abundance of prey, and a top predator. Ecology and Evolution 7, 1964-1973.

289 Ramesh, T., Kalle, R., Downs, C.T., 2017b. Staying safe from top predators: patterns of co-occurrence and inter-predator interactions. Behavioral Ecology and Sociobiology 71, 41.

290 Ramnanan, R., Swanepoel, L.H., Somers, M.J., 2013. The diet and presence of African wild dogs (*Lycaon pictus*) on private land in the Waterberg region, South Africa. African Journal of Wildlife Research 43, 68-73.

291 Rasambainarivo, F., Farris, Z.J., Andrianalizah, H., Parker, P.G., 2017. Interactions between carnivores in Madagascar and the risk of disease transmission. EcoHealth 14, 691-703.

292 Razafindratsima, O.H., 2017. Post-dispersal seed removal by rodents in Ranomafana rain forest, Madagascar. Journal of Tropical Ecology 33, 232.

293 Reece, S.J., Radloff, F.G., Leslie, A.J., Amin, R., Tambling, C.J., 2021. A camera trap appraisal of species richness and community composition of medium and large mammals in a Miombo woodland reserve. African Journal of Ecology 59, 898-911.

294 Rich, L.N., Miller, D.A., Robinson, H.S., McNutt, J.W., Kelly, M.J., 2016. Using camera trapping and hierarchical occupancy modelling to evaluate the spatial ecology of an African mammal community. Journal of Applied Ecology 53, 1225-1235.

295 Rich, L.N., Miller, D.A.W., Robinson, H.S., McNutt, J.W., Kelly, M.J., 2017a. Carnivore distributions in Botswana are shaped by resource availability and intraguild species. Journal of Zoology 303, 90-98.

296 Rich, L.N., Davis, C.L., Farris, Z.J., Miller, D.A., Tucker, J.M., Hamel, S., Farhadinia, M.S., Steenweg, R., Di Bitetti, M.S., Thapa, K., Kane, M.D., Sunarto, S., Robinson, N.P., Paviolo, A., Cruz, P., Martins, Q., Gholikhani, N., Taktehrani, A., Whittington, J., Widodo, F.A., Yoccoz, N.G., Wultsch, C., Harmsen, B.J., Kelly, M.J., 2017b. Assessing global patterns in mammalian carnivore occupancy and richness by integrating local camera trap surveys. Global Ecology and Biogeography 26, 918-929.

297 Rich, L.N., Miller, D.A., Muñoz, D.J., Robinson, H.S., McNutt, J. W., Kelly, M.J., 2019. Sampling design and analytical advances allow for simultaneous density estimation of seven sympatric carnivore species from camera trap data. Biological Conservation 233, 12-20.

298 Rich, A.M., Poindexter, S.A., Lai, A., Steiniche, T.B., Mutegeki, R., Wasserman, M.D., 2020. A camera trap survey in a protected forest with potential for landscape connectivity across Western Uganda. African Journal of Ecology 58, 529-533.

299 Rodrigues, P., Dorresteijn, I., Guilherme, J.L., Hanspach, J., De Beenhouwer, M., Hylander, K., Bekele, B., Senbeta, F., Fischer, J., Nimmo, D., 2021. Predicting the impacts of human population growth on forest mammals in the highlands of southwestern Ethiopia. Biological Conservation 256, 109046.

300 Roesch, M.A., Hansen, D.M., Cole, N.C., 2021. Understanding demographic limiting factors to species recovery: Nest-site suitability and breeding ecology of *Phelsuma guentheri* on Round Island, Mauritius. Global Ecology and Conservation 30, e01761.

301 Roque, D.V., Göttert, T., Macandza, V.A., Zeller, U., 2021. Assessing distribution patterns and the relative abundance of reintroduced large herbivores in the Limpopo National Park, Mozambique. Diversity 13, 456.

302 Rosenblatt, E., Creel, S., Becker, M.S., Merkle, J., Mwape, H., Schuette, P., Simpamba, T., 2016. Effects of a protection gradient on carnivore density and survival: an example with leopards in the Luangwa valley, Zambia. Ecology and Evolution 6, 3772-3785.

303 Ross, P.H., Patel, E., Ferguson, B., Ravelijaona, R.N., Raoloniana, G.I., Wampole, E., Gerber, B.D., Farris, Z.J., 2020. Assessment of the threatened carnivore community in the recently expanded rainforest protected area Anjanaharibe-Sud Special Reserve, Madagascar. Endangered Species Research 43, 89-98.

304 Rottstock, T., Göttert, T., Zeller, U., 2020. Relatively undisturbed African savannas-an important reference for assessing wildlife responses to livestock grazing systems in European rangelands. Global Ecology and Conservation 23, e01124.

305 Rovero, F., Marshall, A.R., 2009. Camera trapping photographic rate as an index of density in forest ungulates. Journal of Applied Ecology 46, 1011-1017.

306 Rovero, F., Jones, T., Sanderson, J., 2005. Notes on Abbott's duiker (*Cephalophus spadix* True 1890) and other forest antelopes of Mwanihana Forest, Udzungwa Mountains, Tanzania, as revealed by camera-trapping and direct observations. Tropical Zoology 18, 13-23.

307 Rovero, F., Rathbun, G.B., Perkin, A., Jones, T., Ribble, D.O., Leonard, C., Mwakisoma, R.R., Doggart, N., 2008. A new species of giant sengi or elephant-shrew (genus *Rhynchocyon*) highlights the exceptional biodiversity of the Udzungwa Mountains of Tanzania. Journal of Zoology 274, 126-133.

308 Rovero, F., Collett, L., Ricci, S., Martin, E., Spitale, D., 2013. Distribution, occupancy, and habitat associations of the gray-faced sengi (*Rhynchocyon udzungwensis*) as revealed by camera traps. Journal of Mammalogy 94, 792-800.

309 Rovero, F., Martin, E., Rosa, M., Ahumada, J.A., Spitale, D., 2014. Estimating species richness and modelling habitat preferences of tropical forest mammals from camera trap data. PLoS ONE 9, e103300.

310 Rovero, F., Owen, N., Jones, T., Canteri, E., Iemma, A., Tattoni, C., 2017. Camera trapping surveys of forest mammal communities in the Eastern Arc Mountains reveal generalized habitat and human disturbance responses. Biodiversity and Conservation 26, 1103-1119.

311 Santangeli, A., Pakanen, V.M., Bridgeford, P., Boorman, M., Kolberg, H., Sanz-Aguilar, A., 2020. The relative contribution of camera trap technology and citizen science for estimating survival of an endangered African vulture. Biological Conservation 246, 108593.

312 Satterfield, L.C., Thompson, J.J., Snyman, A., Candelario, L., Rode, B., Carroll, J.P., 2017. Estimating occurrence and detectability of a carnivore community in eastern Botswana using baited camera traps. African Journal of Wildlife Research 47, 32-46.

313 Schäfer, M., Tsekané, S.J., Tchassem, F.A.M., Drakulić, S., Kameni, M., Gonwouo, N.L., Rödel, M.O., 2019. Goliath frogs build nests for spawning–the reason for their gigantism? Journal of Natural History 53, 1263-1276.

314 Schumann, M., Schumann, B., Dickman, A., Watson, L.H., Marker, L., 2006. Assessing the use of swing gates in game fences as a potential non-lethal predator exclusion technique. South African Journal of Wildlife Research 36, 173-181.

315 Schwabe, F., Göttert, T., Starik, N., Levick, S.R., Zeller, U., 2015. A study on the postrelease behaviour and habitat preferences of black rhinos (*Diceros bicornis*) reintroduced into a fenced reserve in Namibia. African Journal of Ecology 53, 531-539.

316 Searle, C.E., Smit, J., Strampelli, P., Mkuburo, L., Ikanda, D., Macdonald, D.W., Loveridge, A.J., Dickman, A.J., 2021a. Leopard population density varies across habitats and management strategies in a mixed-use Tanzanian landscape. Biological Conservation 257, 109120.

317 Searle, C.E., Smit, J.B., Cusack, J.J., Strampelli, P., Grau, A., Mkuburo, L., Macdonald, D.W., Loveridge, A.J., Dickman, A.J., 2021b. Temporal partitioning and spatiotemporal avoidance among large carnivores in a human-impacted African landscape. PLoS One 16, e0256876.

318 Seufert, V., Linden, B., Fischer, F., 2010. Revealing secondary seed removers: results from camera trapping. African Journal of Ecology 48, 914-922.

319 Sever, Z., 2021. Searching for the okapi (*Okapia johnstoni*) in Semuliki National Park, Uganda. African Journal of Ecology 59, 286-292.

320 Sillero-Zubiri, C., Rostro-García, S., Burruss, D., Matchano, A., Harouna, A., Rabeil, T., 2015. Saharan cheetah *Acinonyx jubatus hecki*, a ghostly dweller on Niger's Termit massif. Oryx 49, 591-594.

321 Simo, F., Difouo Fopa, G., Kekeunou, S., Ichu, I.G., Esong Ebong, L., Olson, D., Ingram, D.J., 2020. Using local ecological knowledge to improve the effectiveness of detecting white-bellied pangolins (*Phataginus tricuspis*) using camera traps: a case study from Deng-Deng National Park, Cameroon. African Journal of Ecology, 1-6.

322 Simon, I., Che, J., Baker, L.R., 2020. University campuses can contribute to wildlife conservation in urbanizing regions: a case study from Nigeria. Journal of Threatened Taxa 12, 16736-16741.

323 Smit, J., Pozo, R. A., Cusack, J.J., Nowak, K., Jones, T., 2019. Using camera traps to study the age–sex structure and behaviour of crop-using elephants *Loxodonta africana* in Udzungwa Mountains National Park, Tanzania. Oryx 53, 368-376.

324 Sogbohossou, E.A., Kassa, B.D., Waltert, M., Khorozyan, I., 2018. Spatio-temporal niche partitioning between the African lion (*Panthera leo leo*) and spotted hyena (*Crocuta crocuta*) in western African savannas. European Journal of Wildlife Research 64, 1.

325 Soiret, S.P.K., Kouakou, C.Y., Koffi, B.C., Kadjo, B., Kouassi, P., Gomez, P.J., Goodwin, R.M., Kone, I., 2019. The diversity and conservation of mammals in the Dodo Coastal Forest in southwestern Côte d'Ivoire, western Africa: a preliminary study. Journal of Threatened Taxa 11, 13654-13666.

326 Soto-Shoender, J.R., McCleery, R.A., Monadjem, A., Gwinn, D.C., 2018. The importance of grass cover for mammalian diversity and habitat associations in a bush encroached savanna. Biological Conservation 221, 127-136.

327 Ssali, F., Sheil, D., 2019. Some initial observations concerning the African wild banana *Ensete ventricosum* as a resource for vertebrates. Tropical Conservation Science 12, 1940082919879318.

328 Ssali, F., Moe, S.R., Sheil, D., 2018. Tree seed rain and seed removal, but not the seed bank, impede forest recovery in bracken (*Pteridium aquilinum* (L.) Kuhn)-dominated clearings in the African highlands. Ecology and Evolution 8, 4224-4236.

329 Stanton-Jones, W.K., Parusnath, S., Alexander, G.J., 2018. The impact of posture and basking orientation on thermoregulation in the sungazer (*Smaug giganteus*). Journal of Thermal Biology 75, 45-53.

330 Stein, A.B., Fuller, T.K., Marker, L.L., 2008. Opportunistic use of camera traps to assess habitat-specific mammal and bird diversity in northcentral Namibia. Biodiversity and Conservation 17, 3579-3587.

331 Stein, A., Erckie, B., Fuller, T.K., Marker, L., 2010. Camera trapping as a method for monitoring rhino populations within the Waterberg Plateau Park, Namibia. Pachyderm 48, 67-70.

332 Stein, A.B., Fuller, T.K., DeStefano, S., Marker, L.L., 2011. Leopard population and home range estimates in north-central Namibia. African Journal of Ecology 49, 383-387.

333 Steinbeiser, C.M., Kioko, J., Maresi, A., Kaitilia, R., Kiffner, C., 2019. Relative abundance and activity patterns explain method-related differences in mammalian species richness estimates. Journal of Mammalogy 100, 192-201.

334 Stommel, C., Hofer, H., East, M.L., 2016a. The effect of reduced water availability in the Great Ruaha River on the vulnerable common hippopotamus in the Ruaha National Park, Tanzania. PLoS ONE 11, e0157145.

335 Stommel, C., Hofer, H., Grobbel, M., East, M.L., 2016b. Large mammals in Ruaha National Park, Tanzania, dig for water when water stops flowing and water bacterial load increases. Mammalian Biology 81, 21-30.

336 Strampelli, P., Andresen, L., Everatt, K.T., Somers, M.J., Rowcliffe, J.M., 2018. Habitat use responses of the African leopard in a human-disturbed region of rural Mozambique. Mammalian Biology 89, 14-20.

337 Strampelli, P., Andresen, L., Everatt, K.T., Somers, M.J., Rowcliffe, J.M., 2020. Leopard (*Panthera pardus*) density in southern Mozambique: evidence from spatially explicit capture–recapture in Xonghile Game Reserve. Oryx 54, 405-411.

338 Strampelli, P., Searle, C.E., Smit, J., Grau, A., Henschel, P., Lobora, A.L., Mitchell, N., Macdonald, D.W., Dickman, A.J., 2021. Insights into the status and distribution of cheetah (*Acinonyx jubatus*) in an understudied potential stronghold in southern Tanzania. African Journal of Ecology 59, 334-341.

339 Stratford, K., Stratford, S., Périquet, S., 2020. Dyadic associations reveal clan size and social network structure in the fission–fusion society of spotted hyaenas. African Journal of Ecology 58, 182-192.

340 Sutherland, K., Ndlovu, M., Pérez-Rodríguez, A., 2018. Use of artificial waterholes by animals in the southern region of the Kruger National Park, South Africa. African Journal of Wildlife Research 48, 023003.

341 Swanepoel, L.H., Somers, M.J., Dalerum, F., 2015. Density of leopards *Panthera pardus* on protected and non-protected land in the Waterberg Biosphere, South Africa. Wildlife Biology 21, 263-268.

342 Swanson, A., Kosmala, M., Lintott, C., Simpson, R., Smith, A., Packer, C., 2015. Snapshot Serengeti, high-frequency annotated camera trap images of 40 mammalian species in an African savanna. Scientific Data 2, 150026.

343 Swanson, A., Arnold, T., Kosmala, M., Forester, J., Packer, C., 2016. In the absence of a “landscape of fear”: how lions, hyenas, and cheetahs coexist. Ecology and Evolution 6, 8534-8545.

344 Symes, C.T., 2017. Notes on the flowering and pollination of the endemic grassland *Aloe reitzii* var. *reitzii* (Asphodelaceae). Bothalia-African Biodiversity & Conservation 47(1), a2215 .

345 Tambling, C.J., Minnie, L., Adendorff, J., Kerley, G.I., 2013. Elephants facilitate impact of large predators on small ungulate prey species. Basic and Applied Ecology 14, 694-701.

346 Tambling, C.J., Minnie, L., Meyer, J., Freeman, E.W., Santymire, R.M., Adendorff, J., Kerley, G.I., 2015. Temporal shifts in activity of prey following large predator reintroductions. Behavioral Ecology and Sociobiology 69, 1153-1161.

347 Tarugara, A., Clegg, B.W., Gandiwa, E., Muposhi, V. K., Wenham, C.M., 2019a. Measuring body dimensions of leopards (*Panthera pardus*) from camera trap photographs. PeerJ 7, e7630.

348 Tarugara, A., Clegg, B.W., Gandiwa, E., Muposhi, V.K., 2019b. Cost-benefit analysis of increasing sampling effort in a baited-camera trap survey of an African leopard (*Panthera pardus*) population. Global Ecology and Conservation 18, e00627.

349 Tarugara, A., Clegg, B.W., Gandiwa, E., Muposhi, V.K., 2021. The effect of competing carnivores on the feeding behaviour of leopards (*Panthera pardus*) in an African savanna. Ecology and Evolution 11, 7743-7753.

350 Thompson, L.J., Davies, J.P., Gudehus, M., Botha, A.J., Bildstein, K.L., Murn, C., Downs, C.T., 2017a. Visitors to nests of Hooded Vultures *Necrosyrtes monachus* in northeastern South Africa. Ostrich 88, 155-162.

351 Thompson, L.J., Davies, J.P., Bildstein, K.L., Downs, C.T., 2017b. Removal (and attempted removal) of material from a Hooded Vulture *Necrosyrtes monachus* nest by a starling and a Hooded Vulture. Ostrich 88, 183-187.

352 Thorn, M., Scott, D.M., Green, M., Bateman, P.W., Cameron, E.Z., 2009. Estimating brown hyaena occupancy using baited camera traps. African Journal of Wildlife Research 39, 1-10.

353 Thorn, M., Green, M., Keith, M., Marnewick, K., Bateman, P.W., Cameron, E.Z., Scott, D.M., 2011. Large-scale distribution patterns of carnivores in northern South Africa: implications for conservation and monitoring. Oryx 45, 579-586.

354 Tichagwa, T., Pegg, N., Ndagurwa, H.G., Zhuwau, C., 2020. Factors influencing the diurnal behaviour of white rhino (*Ceratotherium simum*) in Matobo National Park, Zimbabwe. African Journal of Ecology, 1-12.

355 Torrents-Ticó, M., Rich, L., McNutt, J.W., Nthomiwa, M., Mothala, M., Motsamai, G., Jordan, N.R., 2017. On the right track? Comparing concurrent spoor and camera-trap surveys in Botswana. African Journal of Wildlife Research 47, 128-137.

356 Torrents-Ticó, M., Fernández-Llamazares, Á., Burgas, D., Cabeza, M., 2021. Convergences and divergences between scientific and Indigenous and Local Knowledge contribute to inform carnivore conservation. Ambio 50, 990-1002.

357 Tosso, F., Cherchye, G., Hardy, O.J., Daïnou, K., Lognay, G., Tagg, N., Haurez, B., Souza, A., Heuskin, S., Doucet, J.L., 2018. Characterization of animal communities involved in seed dispersal and predation of *Guibourtia tessmannii* (Harms) J. Léonard, a species newly listed on Appendix II of CITES. African Journal of Ecology 56, 468-476.

358 Treves, A., Mwima, P., Plumptre, A.J., Isoke, S., 2010. Camera-trapping forest–woodland wildlife of western Uganda reveals how gregariousness biases estimates of relative abundance and distribution. Biological Conservation 143, 521-528.

359 Tshabalala, T., McManus, J., Treves, A., Masocha, V., Faulconbridge, S., Schurch, M., Goets, S., Smuts, B., 2021. Leopards and mesopredators as indicators of mammalian species richness across diverse landscapes of South Africa. Ecological Indicators 121, 107201.

360 Turikunkiko, E., Mulindahabi, F., Gatorano, G., Muvunyi, R., Ntihemuka, P., Niyigaba, P., Ndikubwimana, I., Karegire, N., Moore, J.F., 2021. Resighting African wildcats (*Felis lybica*): Camera trap photographs in Nyungwe National Park, Rwanda. African Journal of Ecology 60, 71-74.

361 Turner, R.C., Midgley, J.J., 2016. Sunbird-pollination in the geoflorous species *Hyobanche sanguinea* (Orobanchaceae) and *Lachenalia luteola* (Hyacinthaceae). South African Journal of Botany 102, 186-189.

362 Turner, W.C., Kausrud, K.L., Krishnappa, Y.S., Cromsigt, J.P., Ganz, H.H., Mapaure, I., Cloete, C.C., Havarua, Z., Küsters, M., Getz, W.M., Stenseth, N.C., 2014. Fatal attraction: vegetation responses to nutrient inputs attract herbivores to infectious anthrax carcass sites. Proceedings of the Royal Society B 281(1795), 20141785.

363 van Berkel, T., Sumbane, E., Jones, S.E., Jocque, M., 2019. A mammal survey of the Serra Jeci Mountain Range, Mozambique, with a review of records from northern Mozambique’s inselbergs. African Zoology 54, 31-42.

364 van Blerk, J.J., West, A.G., Midgley, J.J., 2017. Restio culm felling is a consequence of pre-dispersal seed predation by the rodent *Rhabdomys pumilio* in the Fynbos. South African Journal of Botany 112, 123-127.

365 van der Meer, T., McPherson, S., Downs, C., 2018. Temporal changes in prey composition and biomass delivery to African Crowned Eagle nestlings in urban areas of KwaZulu-Natal, South Africa. Ostrich 89, 241-250.

366 Van der Weyde, L.K., Mbisana, C., Klein, R., 2018. Multi-species occupancy modelling of a carnivore guild in wildlife management areas in the Kalahari. Biological Conservation 220, 21-28.

367 Van der Weyde, L.K., Theisinger, O., Mbisana, C., Gielen, M.C., Klein, R., 2021. The value of pastoral ranches for wildlife conservation in the Kalahari. Wildlife Research.

368 van Leeuwen, K.L., Matsuzawa, T., Sterck, E.H., Koops, K., 2020. How to measure chimpanzee party size? A methodological comparison. Primates 61, 1-12.

369 Van Opstal, M., Oosterlynck, B., Belay, M., Erens, J., De Beenhouwer, M., 2019. First assessment of bird diversity in the UNESCO Sheka Forest Biosphere Reserve, southwestern Ethiopia: species richness, distribution and potential for avian conservation. Journal of Threatened Taxa 11, 13850-13867.

370 van Pinxteren, B.O.C.M., Sirianni, G., Gratton, P., Després-Einspenner, M.L., Egas, M., Kühl, H., Lapuente, J., Meier, A.C., Janmaat, K.R.L., 2018. Sooty mangabeys scavenge on nuts cracked by chimpanzees and red river hogs—An investigation of inter-specific interactions around tropical nut trees. American journal of Primatology 80, e22895.

371 Vanthomme, H., Kolowski, J., Korte, L., Alonso, A., 2013. Distribution of a community of mammals in relation to roads and other human disturbances in Gabon, Central Africa. Conservation Biology 27, 281-291.

372 Veldhuis, M.P., Hofmeester, T.R., Balme, G., Druce, D.J., Pitman, R.T., Cromsigt, J.P., 2020. Predation risk constrains herbivores' adaptive capacity to warming. Nature Ecology & Evolution 4, 1069-1074.

373 Verschueren, S., Briers-Louw, W.D., Cristescu, B., Fabiano, E., Nghikembua, M., Torres-Uribe, C., Walker, E.H., Marker, L., 2021a. Spatiotemporal sharing and partitioning of scent-marking sites by cheetahs and leopards in north-central Namibia. African Journal of Ecology 59, 605-613.

374 Verschueren, S., Briers-Louw, W.D., Monterroso, P., Marker, L., 2021b. Local-scale variation in land use practice supports a diverse carnivore guild on Namibian multiple-use rangeland. Rangeland Ecology & Management 79, 64-76.

375 Vink, D.N., Stewart, F.A., Piel, A.K., 2020. Comparing methods for assessing chimpanzee (*Pan troglodytes schweinfurthii*) party size: observations, camera traps, and bed counts from a savanna–woodland mosaic in the Issa Valley, Tanzania. International Journal of Primatology, 1-15.

376 Vinks, M.A., Creel, S., Rosenblatt, E., Becker, M.S., Schuette, P., Goodheart, B., Sanguinetti, C., Banda, K., Simukonda, C., 2021. Leopard *Panthera pardus* density and survival in an ecosystem with depressed abundance of prey and dominant competitors. Oryx, 1-10.

377 Vissia, S., Wadhwa, R., van Langevelde, F., 2021. Co-occurrence of high densities of brown hyena and spotted hyena in central Tuli, Botswana. Journal of Zoology 314, 143-150.

378 Viviano, A., Amori, G., Luiselli, L., Oebel, H., Bahleman, F., Mori, E., 2020. Blessing the rains down in Africa: spatiotemporal behaviour of the crested porcupine *Hystrix cristata* (Mammalia: Rodentia) in the rainy and dry seasons, in the African savannah. Tropical Zoology 33, 113-124.

379 Warbington, C.H., Boyce, M.S., 2020. Population density of sitatunga in riverine wetland habitats. Global Ecology and Conservation 24, e01212.

380 Webber, A.D., Solofondranohatra, J.S., Razafindramoana, S., Fernández, D., Parker, C.A., Steer, M., Abrahams, M., Allainguillaume, J., 2020. Lemurs in cacao: presence and abundance within the shade plantations of Northern Madagascar. Folia Primatologica 91, 96-107.

381 Webster, A.B., Pretorius, M.E., Somers, M.J., 2021. The determinants of mesocarnivore activity patterns in highveld grassland and riparian habitats. African Journal of Wildlife Research 51, 178-192.

382 Weinstein, S.B., Malanga, K.N., Agwanda, B., Maldonado, J.E., Dearing, M.D., 2020. The secret social lives of African crested rats, *Lophiomys imhausi*. Journal of Mammalogy 101, 1680-1691.

383 Weise, F.J., Wessels, Q., Munro, S., Solberg, M., 2014. Using artificial passageways to facilitate the movement of wildlife on Namibian farmland. African Journal of Wildlife Research 44, 161-166.

384 Welch, R.J., Parker, D.M., 2016. Brown hyaena population explosion: rapid population growth in a small, fenced system. Wildlife Research 43, 178-187.

385 Welch, R.J., Grant, T., Parker, D.M., 2019. Using camera traps to generate a species inventory for medium-sized and large mammals in South West Zimbabwe. African Journal of Wildlife Research 49, 89-99.

386 Wells, H.B., Kimuyu, D.M., Odadi, W.O., Dougill, A.J., Stringer, L.C., Young, T.P., 2021. Wild and domestic savanna herbivores increase smaller vertebrate diversity, but less than additively. Journal of Applied Ecology 58, 953-963.

387 Wentzel, J., Gall, C., Bourn, M., De Beer, J., du Plessis, F., Fosgate, G.T., 2021. Carnivore detection at the domestic/wildlife interface within Mpumalanga Province, South Africa. Animals 11, 2535.

388 Wester, P., 2019. First observations of nectar-drinking lizards on the African mainland. Plant Ecology and Evolution 152, 78-83.

389 White, J.D., Bronner, G.N., Midgley, J.J., 2017. Camera-trapping and seed-labelling reveals widespread granivory and scatter-hoarding of nuts by rodents in the Fynbos Biome. African Zoology 52, 31-41.

390 Whytock, R.C., Abwe, E.E., Mfossa, D.M., Ketchen, M.E., Abwe, A.E., Nguimdo, V.R.V., Maisels, F., Strindberg, S., Morgan, B.J., 2021. Mammal distribution and trends in the threatened Ebo'intact forest landscape', Cameroon. Global Ecology and Conservation 31, e01833.

391 Widdows, C.D., Ramesh, T., Downs, C.T., 2015. Factors affecting the distribution of large spotted genets (*Genetta tigrina*) in an urban environment in South Africa. Urban Ecosystems 18, 1401-1413.

392 Widness, J., Aronsen, G.P., 2018. Camera trap data on mammal presence, behaviour and poaching: a case study from Mainaro, Kibale National Park, Uganda. African Journal of Ecology 56, 383-389.

393 Wilkinson, C.E., McInturff, A., Kelly, M., Brashares, J.S., 2021. Quantifying wildlife responses to conservation fencing in East Africa. Biological Conservation 256, 109071.

394 Williams, D., Pettorelli, N., Henschel, J., Cowlishaw, G., Douglas, C.M., 2014. Impact of alien trees on mammal distributions along an ephemeral river in the Namib Desert. African Journal of Ecology 52, 404-413.

395 Williams, S.T., Williams, K.S., Lewis, B.P., Hill, R.A., 2017. Population dynamics and threats to an apex predator outside protected areas: implications for carnivore management. Royal Society Open Science 4, 161090.

396 Williams, S.T., Maree, N., Taylor, P., Belmain, S.R., Keith, M., Swanepoel, L.H., 2018a. Camera trap and questionnaire dataset on ecosystem services provided by small carnivores in agro-ecosystems in South Africa. Data in Brief 18, 753-759.

397 Williams, S.T., Maree, N., Taylor, P., Belmain, S.R., Keith, M., Swanepoel, L.H., 2018b. Predation by small mammalian carnivores in rural agro-ecosystems: an undervalued ecosystem service? Ecosystem Services 30, 362-371.

398 Williams, K.S., Pitman, R.T., Mann, G.K.M., Whittington-Jones, G., Comley, J., Williams, S.T., Hill, R.A., Balme, G.A., Parker, D.M., 2021a. Utilizing bycatch camera-trap data for broad-scale occupancy and conservation: a case study of the brown hyaena *Parahyaena brunnea*. Oryx 55, 216-226.

399 Williams, K.S., Williams, S.T., Welch, R.J., Marneweck, C.J., Mann, G.K., Pitman, R.T., Whittington-Jones, G., Balme, G.A., Parker, D.M., Hill, R.A., 2021b. Assumptions about fence permeability influence density estimates for brown hyaenas across South Africa. Scientific Reports 11, 1-11.

400 Winterbach, C.W., Maude, G., Neo-Mahupeleng, G., Klein, R., Boast, L., Rich, L.N., Somers, M.J., 2017. Conservation implications of brown hyaena (*Parahyaena brunnea*) population densities and distribution across landscapes in Botswana. Koedoe 59, a1441.

401 Winterton, D.J., Van Wilgen, N.J., Venter, J.A., 2020. Investigating the effects of management practice on mammalian co-occurrence along the West Coast of South Africa. PeerJ 8, e8184.

402 Wood, B.M., Millar, R.S., Wright, N., Baumgartner, J., Holmquist, H., Kiffner, C., 2021. Hunter-Gatherers in context: Mammal community composition in a northern Tanzania landscape used by Hadza foragers and Datoga pastoralists. PLoS One 16, e0251076.

403 Woodgate, Z., Distiller, G., Riain, M.J.O., 2021. Hare today, gone tomorrow: the role of interspecific competition in shaping riverine rabbit occurrence. Endangered Species Research 44, 351-361.

404 Wreford, E.P., Hart, L.A., Brown, M., Downs, C.T., 2017. Black Sparrowhawk *Accipiter melanoleucus* breeding behaviour and reproductive success in KwaZulu-Natal, South Africa. Ostrich 88, 287-290.

405 Zero, V.H., Sundaresan, S.R., O'Brien, T.G., Kinnaird, M.F., 2013. Monitoring an endangered savannah ungulate, Grevy's zebra *Equus grevyi*: choosing a method for estimating population densities. Oryx 47, 410-419.

406 Zungu, M.M., Maseko, M.S.T., Kalle, R., Ramesh, T., Downs, C.T., 2019. Fragment and life-history correlates of extinction vulnerability of forest mammals in an urban-forest mosaic in EThekwini Municipality, Durban, South Africa. Animal Conservation 22, 362-375.

407 Zungu, M.M., Maseko, M.S., Kalle, R., Ramesh, T., Downs, C.T., 2020a. Effects of landscape context on mammal richness in the urban forest mosaic of EThekwini Municipality, Durban, South Africa. Global Ecology and Conservation 21, e00878.

408 Zungu, M.M., Maseko, M.S., Kalle, R., Ramesh, T., Downs, C.T., 2020b. Factors affecting the occupancy of forest mammals in an urban-forest mosaic in EThekwini Municipality, Durban, South Africa. Urban Forestry & Urban Greening 48, 126562.

Supplementary Information Table S2.3. Summary of camera trap studies conducted in African countries and their percentage total contribution to all publications between 2005 and 2021.

African country	Area of country (km^2)	Studies conducted per km^2	Camera trap studies conducted	Percentage of camera trap studies (%)
South Africa	1,221,037	0.000101553	124	28.9
Tanzania	945,087	0.0000539633	51	11.9
Namibia	825,615	0.0000327029	27	6.3
Gabon	267,668	0.0000971353	26	6.1
Kenya	580,367	0.000037907	22	5.1
Madagascar	587,041	0.0000357726	21	4.9
Botswana	582,000	0.000032646	19	4.4
Uganda	241,550	0.0000745187	18	4.2
Cameroon	475,442	0.0000294463	14	3.3
Democratic Rep. of Congo	2,344,858	0.0000051176	12	2.8
Mozambique	801,590	0.0000137227	11	2.6
Zimbabwe	390,757	0.0000230322	9	2.1
Ivory Coast	322,463	0.000024809	8	1.9
Senegal	196,722	0.0000406665	8	1.9
Ethiopia	1,104,300	0.0000063389	7	1.6
Rwanda	26,338	0.0001898398	5	1.2
Niger	1,267,000	0.0000031571	4	0.9
Angola	1,246,700	0.0000024064	3	0.7
Burkina Faso	272,967	0.0000109903	3	0.7
Central African Republic	622,984	0.0000048155	3	0.7
Ghana	238,533	0.0000125769	3	0.7
Malawi	118,484	0.0000253199	3	0.7
Republic of the Congo	342,000	0.0000087719	3	0.7
Sierra Leone	71,740	0.0000418177	3	0.7
Benin	112,622	0.0000177585	2	0.5
Guinea	245,857	0.0000081348	2	0.5
Guinea-Bissau	36,125	0.0000553633	2	0.5
Mauritius	2,040	0.0009803922	2	0.5
Morocco	446,550	0.0000044788	2	0.5
Swaziland	17,364	0.0001151808	2	0.5
Tunisia	163,610	0.0000122242	2	0.5
Zambia	752,612	0.0000026574	2	0.5
Algeria	2,381,741	0.0000004199	1	0.2
Equatorial Guinea	28,051	0.0000356494	1	0.2
Liberia	111,369	0.0000089792	1	0.2
Nigeria	923,768	0.0000010825	1	0.2
Seychelles	452	0.0022123894	1	0.2
Togo	56,785	0.0000176103	1	0.2

Supplementary Information Table S2.4. African countries where no published camera trap studies were found in the present study.

African countries excluded from camera trap studies	
Burundi	Lesotho
Cape Verde	Libya
Chad	Mali
Comoros	Mauritania
Djibouti	São Tomé and Príncipe
Egypt	Somalia
Eritrea	South Sudan
Gambia	Sudan

Supplementary Information Table S2.5. The family, genus or species of all the terrestrial animals which received attention from camera trap studies conducted in African countries and the total number of studies published for each from 2005-2021. Some of the mammals were further grouped as small, medium or large carnivore or herbivore.

Family studied	**Genus studies**	**Species studied**	**Taxon**	**Number of studies conducted**
		Aethina tumida	Insect	1
		Apis mellifera adansonii	Insect	1
		Conraua goliath	Amphibian	1
		Crocodylus niloticus	Reptile	1
		Hemicordylus capensis	Reptile	1
		Karusasaurus polyzonus	Reptile	1
		Ouroborus cataphractus	Reptile	1
		Phelsuma guentheri	Reptile	1
		Rhoptropella ocellata	Reptile	1
		Smaug giganteus	Reptile	1
		Accipiter melanoleucus	Avian	1
		Agelestres meleagrides	Avian	1
		Anous stolidus	Avian	1
		Anous tenuirostris	Avian	1
		Anthobaphes violacea	Avian	1
		Aplopelia larvata	Avian	2
		Aquila verreauxii	Avian	1
		Buphagus africana	Avian	1
		Buphagus erythrorhynus	Avian	1
		Copsychus albospecularis	Avian	1
		Coua serriana	Avian	1
		Geobiastes squamiger	Avian	1
		Geokichla gurneyi	Avian	1
		Guttera edouardi	Avian	1
		Guttera verreauxi	Avian	1
		Gygis alba	Avian	1
		Gyps africanus	Avian	1
		Lophotibis cristata	Avian	1
		Mentocrex kioloides	Avian	1
		Necrosyrtes monachus	Avian	2
		Nectarinia famosa	Avian	1
Nectariniidae			Avian	1
		Phaethon lepturus	Avian	1
		Polyboroides radiatus	Avian	1
		Pternistis afer	Avian	1
		Sarothrura ayresi	Avian	3
		Stephanoaetus coronatus	Avian	2

	Struthio camelus	Avian	1
	Torgos tracheliotos	Avian	1
	Zoothera guttata	Avian	1
	Bos taurus	Domestic mammal	3
	Canis familiaris	Domestic mammal	3
	Capra aegagrus hircus	Domestic mammal	1
	Equus africanus	Domestic mammal	1
	Felis catus	Domestic mammal	1
	Ovis aries	Domestic mammal	2
	Sus scrofa domesticus	Domestic mammal	1
	Cricetomys emini	Rodent	1
	Cricetomys gambianus	Rodent	2
Eliurus spp.		Rodent	2
	Hystrix africaeaustralis	Rodent	3
	Hystrix cristata	Rodent	2
	Lophiomys imhausi	Rodent	2
Nesomys spp.		Rodent	2
	Rhabdomys pumilio	Rodent	1
Scrunidae spp.		Rodent	1
	Phataginus tricuspis	Small insectivore/ carnivore	1
	Smutsia gigantea	Small insectivore/ carnivore	1
	Rhynchocyon chrysopygus	Small omnivore	2
Rhynchocyon spp.		Small omnivore	1
	Rhynchocyon udzungwensis	Small omnivore	2
	Setifer setosus	Small omnivore	2
	Tenrec ecaudatus	Small omnivore	2
	Avahi laniger	Primate	1
	Avahi peyrierasi	Primate	1
	Cercocebus atys	Primate	1
	Cercocebus sanjei	Primate	1
	Cercopithecus hamlyni	Primate	1
	Cercopithecus mitis	Primate	1
	Cheirogaleus major	Primate	2
Cheirogaleus spp.		Primate	1
	Chlorocebus dryas	Primate	1
	Chlorocebus pygerythrus	Primate	4
	Colobus guereza	Primate	1
	Daubentonia madagascariensis	Primate	2
	Eulemur albifrons	Primate	1
	Eulemur rubriventer	Primate	2
	Eulemur rufifrons	Primate	2
	Galago moholi	Primate	1
	Gorilla gorilla gorilla	Primate	4
	Hapalemur griseus	Primate	2
	Indri indri	Primate	1
	Lemur catta	Primate	1

	Mandrillus sphinx	Primate	2
	Microcebus jollyae	Primate	1
	Microcebus rufus	Primate	1
	Microcebus sambiranensis	Primate	1
	Mirza zaza	Primate	1
	Otolemur crassicaudatus	Primate	1
	Pan troglodytes ellioti	Primate	2
	Pan troglodytes schweinfurthii	Primate	4
	Pan troglodytes troglodytes	Primate	9
	Pan troglodytes verus	Primate	13
	Papio anubis	Primate	2
	Papio cynocephalus	Primate	1
	Papio ursinus	Primate	2
	Phaner furcifer	Primate	1
	Phaner parienti	Primate	1
	Prolemur simus	Primate	2
	Propithecus candidus	Primate	1
	Varecia rubra	Primate	1
	Varecia variegata	Primate	2
	Aonyx capensis	Small carnivore	1
	Aonyx congicus	Small carnivore	1
	Atilax paludinosus	Small carnivore	4
	Bdeogale crassicauda	Small carnivore	3
	Bdeogale jacksoni	Small carnivore	1
	Civettictis civetta	Small carnivore	7
	Crossarchus ansorgei	Small carnivore	1
	Cryptoprocta ferox	Small carnivore	7
	Cynictis penicillata	Small carnivore	3
	Eupleres goudotii	Small carnivore	1
	Felis silvestris	Small carnivore	2
	Felis silvestris catus	Small carnivore	3
	Felis silvestris lybica	Small carnivore	4
Felis spp.		Small carnivore	1
	Fossa fossana	Small carnivore	2
	Galerella Pulverulenta	Small carnivore	1
	Galerella sanguinea	Small carnivore	2
	Galidia elegans	Small carnivore	2
	Galidictis fasciata	Small carnivore	1
	Genetta genetta	Small carnivore	1
	Genetta maculata	Small carnivore	5
	Genetta servalina	Small carnivore	2
	Genetta servalina lowei	Small carnivore	1
	Genetta tigrina	Small carnivore	4
	Herpestes ichneumon	Small carnivore	2
	Herpestes sanguineus	Small carnivore	2
	Ichneumia albicauda	Small carnivore	1

Ictonyx striatus	Small carnivore	2
Mellivora capensis	Small carnivore	9
Mungos mungo	Small carnivore	2
Nandinia binotata	Small carnivore	2
Otocyon megalotis	Small carnivore	2
Proteles cristata	Small carnivore	4
Salanoia concolor	Small carnivore	1
Viverricula indica	Small carnivore	2
Vulpes chama	Small carnivore	3
Vulpes rueppellii	Small carnivore	1
Vulpes zerda	Small carnivore	1
Canis adustus	Medium carnivore	2
Canis anthus	Medium carnivore	1
Canis lupaster	Medium carnivore	1
Canis mesomelas	Medium carnivore	8
Caracal aurata	Medium carnivore	5
Caracal caracal	Medium carnivore	6
Hyaena hyaena	Medium carnivore	3
Leptailurus serval	Medium carnivore	13
Vulpes vulpes	Medium carnivore	1
Panthera leo leo	Large carnivore	2
Acinonyx jubatus	Large carnivore	17
Acinonyx jubatus hecki	Large carnivore	2
Crocuta crocuta	Large carnivore	23
Hyaena brunnea	Large carnivore	14
Lycaon pictus	Large carnivore	10
Panthera leo	Large carnivore	24
Panthera pardus	Large carnivore	60
Bunolagus monticularis	Small herbivore	1
Cephalohpus weynsi	Small herbivore	1
Cephalophus adersi	Small herbivore	2
Cephalophus callipygus	Small herbivore	1
Cephalophus harveyi	Small herbivore	6
Cephalophus leucogaster	Small herbivore	1
Cephalophus natalensis	Small herbivore	2
Cephalophus nigrifrons	Small herbivore	1
Cephalophus ogilbyi	Small herbivore	2
Cephalophus spadix	Small herbivore	4
Madoqua kirkii	Small herbivore	1
Nesotragus moschatus	Small herbivore	4
Philantomba monticola	Small herbivore	9
Raphicerus campestris	Small herbivore	2
Sylvicapra grimmia	Small herbivore	7
Aepyceros melampus	Medium herbivore	5
Alcelaphus buselaphus caama	Medium herbivore	2
Antidorcas marsupialis	Medium herbivore	2

Cephalophus dorsalis	Medium herbivore	2
Cephalophus silvicultor	Medium herbivore	3
Damaliscus pygargus pygargus	Medium herbivore	1
Eudorcas thomsonii	Medium herbivore	2
Okapia johnstoni	Medium herbivore	1
Phacochoerus africanus	Medium herbivore	3
Potamochoerus larvatus	Medium herbivore	6
Potamochoerus porcus	Medium herbivore	2
Redunca arundinum	Medium herbivore	1
Tragelaphus angasii	Medium herbivore	3
Tragelaphus eurycerus	Medium herbivore	2
Tragelaphus scriptus	Medium herbivore	8
Tragelaphus spekii	Medium herbivore	1
Alcelaphus buselaphus	Large herbivore	1
Alcelaphus buselaphus cokii	Large herbivore	1
Ceratotherium simum	Large herbivore	3
Ceratotherium simum simum	Large herbivore	2
Choeropsis liberiensis	Large herbivore	1
Connochaetes taurinus	Large herbivore	6
Damaliscus korrigum	Large herbivore	1
Damaliscus lunatus jimela	Large herbivore	1
Diceris bicornis	Large herbivore	4
Equus grevyi	Large herbivore	2
Equus quagga	Large herbivore	6
Equus quagga burchelli	Large herbivore	1
Equus zebra zebra	Large herbivore	1
Giraffa camelopardalis	Large herbivore	2
Giraffa camelopardalis reticulata	Large herbivore	1
Hippopotamus amphibius	Large herbivore	1
Hippotragus equinus	Large herbivore	1
Hippotragus niger	Large herbivore	1
Hippotragus niger variani	Large herbivore	1
Kobus ellipsiprymnus	Large herbivore	1
Loxodonta cyclotis	Large herbivore	8
Loxondonta africana	Large herbivore	13
Oryx gazelle	Large herbivore	2
Syncerus caffer	Large herbivore	6
Taurotragus derbianus	Large herbivore	1
Taurotragus derbianus derbianus	Large herbivore	2
Taurotragus oryx	Large herbivore	4
Tragelaphus strepsiceros	Large herbivore	3

Supplementary Information Table S2.6. Summary of camera trap studies in Africa focused on species communities in different habitat types between 2005-2021.

Habitat type	Number of species	Reference
N/A	105 mammals	Ahumada et al., 2011
Rainforest, swamp, forest	10 antelope species	Amin et al., 2021a
Forest, savannah woodland	32 mammals	Assou et al., 2021
Lowland mixed forest, savannah	43 mammals	Bessone et al., 2020
Shrubby, low native vegetation, alien plants, upland forests, invaded native forest	8 mammals	Bissessur et al., 2019
Terra firme forest, monodominant forest and seasonally inundated forests	39 mammals	Bruce et al., 2018
Savannah, thicket, grassland, shrubland	32 mammals	Burt et al., 2021
Open savanna woodland	9 carnivores	Burton et al., 2011
Open savanna woodland	9 carnivores	Burton et al., 2012
Wetlands, a wooded stand of poplar trees, grassland and boulder-strewn sandstone outcrops.	18 mammals	Buschke, 2016
Mosaic of closed forest blocks, dry forest, woodland and wooded grassland	48 medium-large mammals	Cavada et al., 2019
Grassland, woodland, riverine, forests	17 herbivores, 11 carnivores	Clauss et al., 2021
Sandy Grassland and high-altitude palustrine wetland	15 mammals	Colyn et al., 2017
Riverine	9 mammals	Connolly et al., 2021
Savanna broad-leaf woodland, open grassland, wooded grassland	16 carnivores	Curveira-Santos et al., 2021a
Savannah, thicket, forest, grassland	22 mesocarnivores	Curveira-Santos et al., 2021b
East African semi-arid savannah, Zambesian miombo woodland	41 medium-large mammals	Cusack et al., 2015
Nama Karoo, Succulent Karoo, fynbos	36 mammals	Drouilly and O’Riain, 2019
Nama Karoo, Succulent Karoo, fynbos	42 mammals	Drouilly et al., 2018
Acacia-Commiphora Bushlands and Thickets, savannah	34 mammals	Dupuis-Désormeaux et al., 2015
Acacia-Commiphora Bushlands and Thickets, savannah	29 mammals	Dupuis-Désormeaux et al., 2016a
Acacia-Commiphora Bushlands and Thickets, savannah	37 mammals, 2 avian	Dupuis-Désormeaux et al., 2016b
Acacia-Commiphora Bushlands and Thickets, savannah	22 mammals	Dupuis-Désormeaux et al., 2018
Miombo woodlands, grasslands, riverine forest	30 mammals	Easter et al., 2019
Coastal Scarp Forest, Lowland Coastal Forest, thicket/dense bush	29 mammals	Ehlers Smith et al., 2017
Coastal Scarp Forest, Lowland Coastal Forest, thicket/dense bush	20 mammals	Ehlers Smith et al., 2020
Coffee plantation, rainforest	23 mammals	Etana et al., 2021
Evergreen forest	14 mammals	Evrard et al., 2019
Rainforest, degraded forest	~8 carnivores	Farris et al., 2017
Agricultural, riparian, mountainous	4 large carnivores	Fink et al., 2020
Forest	29 mammals	Fonteyn et al., 2021
Grassland, woodland, swamps, semi-deciduous forest	27 mammals	Fuda et al., 2018
Forest	16 mammals, 4 avian	Gaugris et al., 2021

Grassland, woodland savannah, forest	38 mammals	Gaynor et al., 2021
Forest, savannah, scrub, grassland, plantations	38 mammals	Gebert et al., 2019
Forest, scrub	135 dung beetle species	Gebert et al., 2020
Rainforest	6 carnivores	Gerber et al., 2010
Rainforest	8 mammals	Gerber et al., 2012
Forest	25 mammals	Gessner et al., 2014
Forest, plantations	8 carnivores	Gil-Sánchez et al., 2021
Bushveld, rocky hills	19 carnivores	Greco et al., 2021
Afrotemperate forest	12 mammals	Hanekom and Randall 2015
Tropical evergreen forest	1 primate, 2 avian	Haurez et al., 2015
Miombo woodland	49 medium-large mammals	Hausser et al., 2017
Savanna	30 mammals	Hayward and Hayward, 2012
Rainforest, savanna	31 mammals	Hedwig et al., 2018
Forest	24 mammals	Hegerl et al., 2017
Savannah, woodland, thicket	33 mammals	Janecke 2021
Rank grassland	2 avian	Johnson and Van der Niet, 2019
Waterberg Biosphere	15 mammals	Jooste et al., 2013
Rangeland	13 carnivores	Kauffman et al., 2007
Grassland, bushland	30 mammals	Kavwele et al., 2017
Indigenous forest	2 mammals	Kiepiel and Johnson, 2019
Woodland, savannah, bushland	50 mammals, 14 avian, 5 livestock, domestic dogs	Kinnaird and O'Brien, 2012
Protea dominated fynbos	8 small mammals, 3 avian	Kühn et al., 2017
Forest	26 mammals	Lhoest et al., 2020
Rocky outcrops	3 mammals	Lombardi et al., 2017
Fynbos, subtropical thicket, riverine vegetation	33 mammals	Mann et al., 2015
Mountain fynbos, thicket, succulent Karoo	51 mammals (Little Karoo), 22 mammals (Boland)	Mann et al., 2019
Forest	24 mammals	Marracoli et al., 2019
Forest	26 medium-large mammals	Martin et al., 2015
Forest	21 mammals	Martin et al., 2017
N/A	46 mammals (30 in Spain and 16 mammals in South Africa)	Mateo-Tomás et al., 2017
Swamp, grassland, wooded grassland, woodland, gallery forest, thicket forest, hill forest	15 mammals	Mayengo et al., 2020
Forest and swamps	6 ungulate species	McCollum et al., 2018
Forest	19 large mammals	Mertens et al., 2020
Savannah	14 mammals	Mills and Harris, 2020
Thicket	4 mammals, 6 avian	Mokotjomela and Hoffmann, 2013
Rainforest, bamboo forest, savannah, swamp	99 mammals	Moore et al., 2020
Forest	12 mammals	Moupela et al., 2014
N/A	43 mammals	Msuha et al., 2012
Moist evergreen forest	20 mammals, 4 avian	Mugerwa et al., 2013
Forest	28 avian	Murphy et al., 2018

Forest, savannah	29 medium-large mammals	Nakashima, 2015
Thornbush savannah	14 mammals	Nghikembua et al., 2020
N/A	9 large mammals	Niang and Ndiaye, 2021
Mountain tropical forest	1 mammal	Nyiramana et al., 2011
Highland forests	25 mammals	Oberosler et al., 2020
Evergreen forest	20 mammals	Omeja et al., 2016
Forest, savannah, grassland	21 mammals	Orban et al., 2018
N/A	N/A	Page-Nicholson et al., 2018
N/A	2 mammals	Patterson et al., 2016
Mountain Bushveld	4 mammals, 12 avian, 1 reptile	Payne et al., 2019
Forest, savannah, woodland	23 carnivores	Pettorelli et al., 2010
Sourveld grassland, forest, sand forest, thicket, savannah, plantation	38 mammals	Ramesh et al., 2016a
Plantation, sand forest, woodland, grassland, riverine forest, forest, thicket	39 mammals	Ramesh et al., 2016b
Lowland tropical rainforest	8 carnivores	Rasambainarivo et al., 2017
Rainforest	1 mammal	Razafindratsima, 2017
Miombo woodland, thicket, riverine	35 mammals	Reece et al., 2021
Grassland, woodland savannah, shrubland, woodland	44 mammals	Rich et al., 2016
N/A	96 carnivores	Rich et al., 2017a,b
Forest	17 mammals	Rich et al., 2020
Forest	32 mammals	Rodrigues et al., 2021
Forest	6 carnivores	Ross et al., 2020
Mixed woodland savannah, grasslands, grassland savanna, woody vegetation	23 mammals (Namibia)	Rottstock et al., 2020
Forest	26 mammals	Rovero et al., 2014
Forest	43 mammals	Rovero et al., 2017
Rocky outcrops, thicket	13 carnivores	Satterfield et al., 2017
Thornbush Savanna	12 mammals	Schumann et al., 2006
Grassland, forest	10 mammals	Seufert et al., 2010
Woodland, savannah, grassland	4 mammals	Simon et al., 2020
Forest, rainforest, mangrove, savannah, thicket	23 mammals	Soiret et al., 2019
Savannah, riparian forest	21 mammals	Soto-Shoender et al., 2018
Forest	11 mammals	Ssali and Sheil, 2019
Forest	~8 mammals	Ssali et al., 2018
Rocky outcrop, bush savanna, mixed tree and shrub woodland	37 mammals, 25 avian	Stein et al., 2008
Grassland, bushland, groundwater forests	38 mammals	Steinbeiser et al., 2019
Riverine	7 mammals, 1 avian	Stommel et al., 2016
N/A	26 mammals	Sutherland et al., 2018
Savannah, savannah woodlands	40 mammals	Swanson et al., 2015
N/A	~9 mammals	Symes, 2017
Thicket, grassland	12 mammals	Tambling et al., 2013
Kalahari shrubland	21 mammals	Torrents-Ticó et al., 2017
Riverine, grassland, bushland	7 carnivores	Torrents-Ticó et al., 2021
Evergreen forest	4 mammals, 4 avian	Tosso et al., 2018
Forest, woodland	36 large mammals	Treves et al., 2010

Forest, fynbos, Nama Karoo, succulent karoo	43 mammals	Tshabalala et al., 2021
Forest, savannah grassland, wetland	7 mammals	Turikunkiko et al., 2021
Grassland, rocky outcrops, forest	27 mammals	van Berkel et al., 2019
Sandveld	37 mammals	Van der Weyde et al., 2022 (online in 2021)
Forest, wetland	244 species	Van Opstal et al., 2019
Grassland, forest, wetland	17 mammals	Vanthomme et al., 2013
Savannah	19 mammals	Veldhuis et al., 2020
Thornveld, shrubland, woodland	43 mammals	Verschueren et al., 2021
Bushveld savannah, grassland, woodland, rocky outcrops	13 mesocarnivores	Webster et al., 2021
N/A	11 mammals	Weise et al., 2014
Savannah	27 medium-large mammals	Welch et al., 2019
Savannah	49 mammals and avian	Wells et al., 2021
Savannah, woodland, grassland	15 mammals	Wentzel et al., 2021
Fynbos	8 small mammals	White et al., 2017
Forest, plantations	18 mammals	Whytock et al., 2021
Forest, rainforest, grassland	12 mammals	Widness and Aronsen, 2018
Savannah, woodland	38 mammals	Wilkinson et al., 2021
Woodland, riverine	23 mammals	Williams et al., 2014
Bushveld, woodland	12 mammals	Williams et al., 2018a
Bushveld, woodland	9 small-medium carnivores	Williams et al., 2018b
Woodland savannah, grassland	36 mammals	Wood et al., 2021
Forest, grassland	16 mammals	Zungu et al., 2019
Forest, grassland	16 mammals	Zungu et al., 2020a

Supplementary Information Table S2.7 Habitat types where camera trap studies were conducted in Africa with the total number of studies conducted in each from 2005-2021.

Habitat	**Number of studies conducted**
Agricultural	5
Aquatic	1
Desert	8
Forest	174
Fynbos/renosterveld	19
Grassland	100
Mangroves	3
Mountainous	2
Nama Karoo	7
Plantations	18
Rainforest	28
Riverine/riparian	17
Rocky hillsides/outcrops	19
Sand dune	1
Sand forest	6
Sandveld	2
Savanna woodland	26
Savannah grassland	6
Savannah/bushveld	145
Scrubby woodlands	2
Shrubland	21
Succulent Karoo	12
Swamp	10
Swamp forest	9
Thicket	43
Thornbush Savanna	1
Thornveld	2
Waterberg Biosphere	1
Wetland	15
Wooded grasslands	7
Woodland	87

Supplementary Information Table S2.8. Summary of camera trap publications in Africa from 2005-2021 used in the review highlighting camera trap information

Reference	Camera make and model	Camera flash	Camera quality	Camera trigger time (sec)	Detection range (m)	Interval delay	Camera multishot	Camera photo video	Height Placed (cm)
Abade et al.,., 2018	Reconyx HC500, Bushnell Scoutguard	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30-50
Abade et al.,., 2020	Reconyx HC500, Bushnell Scoutguard	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30-50
Abu Baker and Brown, 2014	Moultrie D050 Trail Camera, Cuddeback Excite	N/A	N/A	N/A	N/A	20 min	N/A	N/A	N/A
Adams et al., 2017	Bushnell Trophy Cam Brown HD	N/A	N/A	N/A	N/A	3 sec	N/A	N/A	150-180
Aebischer et al., 2017	Bushnell camera traps (Trophy Cams 119436-119776), Cuddeback Professional NoFlash (Model 1354), Reconyx HC500 HyperFire Semi-Covert IR.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	40-60
Aebischer et al., 2020	Bushnell Trophy Cams 119436-119776, Reconyx HC500 HyperFire Semi-Covert IR	N/A	N/A	N/A	N/A	1 sec-3 min	3 pictures	N/A	~50
Ahumada et al., 2011	Reconyx RM45	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alempijevic et al., 2021	Bushnell model 119636, 119736, 119774, 119837	N/A	N/A	N/A	N/A	N/A	N/A	60 sec	~218
Alexander and Nichols, 2020	N/A	N/A	N/A	N/A	N/A	10 sec	N/A	N/A	N/A
Allen et al., 2018	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Amin et al., 2015	Reconyx RM45	I/R at night	N/A	0.1	N/A	No delay	3 pictures	N/A	30-45
Amin et al., 2021a	Bushnell Trophy Aggressor	N/A	N/A	N/A	N/A	2 sec	3 pictures	N/A	~30
Amin et al., 2021b	Bushnell Trophy Cam, Reconyx RM45	Infrared	N/A	0.1 (Reconyx), 0.2 (Bushnell)	25	N/A	3 pictures	N/A	30-45
Amoroso et al., 2020	Bushnell 119875C Trophy Cam	N/A	N/A	N/A	N/A	N/A	N/A	1 min (day), 15 sec (night)	N/A
Andanje et al., 2011	Stealth Cam STC-1590IR	N/A	N/A	N/A	N/A	1 min	2 pictures	N/A	30-60
Anderson et al., 2016	Scoutguard SG565	Passive Infrared	N/A	N/A	N/A	N/A	N/A	N/A	~50
Anderson et al., 2017	Stealth Cam model STC-DHIRHD/S1, Stealth STC-PRHD1, Bushnell HD model 119440	N/A	Stealth camera (1280 x 720), Bushnell camera (1980 x 1080)	N/A	N/A	5-45 sec	N/A	1 min-3 min	50-130
Andresen et al., 2012	Reconyx HC500, Bushneil Trophy Cam, TrailMaster, DeerCam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Andresen et al., 2014	Reconyx HC500, Bushnell Trophy Cam, SpyPoint Tiny-W2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~15

Angelici et al., 2012	Multipir 12 850 nm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Araldi et al., 2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Assou et al., 2021	Cuddeback Ambush IR, Cuddeback Professional Color	Infrared	N/A	N/A	N/A	15 sec	N/A	N/A	40-90
Bahaa-el-din et al., 2016	Panthera v3 & v4, ScoutGuard SG565F, DeerCam 200	white-flash	N/A	N/A	N/A	N/A	N/A	N/A	~25
Balme et al., 2009a	DeerCam	N/A	N/A	N/A	N/A	5 min	N/A	N/A	20-40
Balme et al., 2009b	DeerCam	N/A	N/A	N/A	N/A	5 min	N/A	N/A	20-40
Balme et al., 2019	Panthera v6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~40
Barandongo et al., 2018	Reconyx RC 55 RapidFire, Reconyx PC800 HyperFire	N/A	N/A	N/A	N/A	N/A	10 (1 second intervals)	N/A	N/A
Beattie et al., 2020	Bushnell Trophy Cam HD, Reconyx PC800 Hyperfire IR	N/A	N/A	N/A	N/A	1 sec	3 pictures	N/A	N/A
Beaudrot et al., 2020	ScoutGuard SG565	Passive Infrared	N/A	1.31	25	N/A	N/A	N/A	~50
Belbachir et al., 2015	Reconyx RC55	Passive infrared	N/A	N/A	N/A	N/A	Rapid fire (duration of the camera being triggered)	N/A	~40
Bersacola et al., 2021	N/A	N/A	N/A	N/A	N/A	N/A	3 pictures	N/A	N/A
Bessa et al., 2021	Bushnell Trophy Cam HD Aggressor	N/A	N/A	N/A	N/A	N/A	N/A	60 sec	N/A
Bessone et al., 2020	Bushnell Trophy CamTM 119776	N/A	N/A	N/A	N/A	1 sec	N/A	N/A	70-90
Bissessur et al., 2019	Bushnell Trophy Cam HD	N/A	N/A	N/A	N/A	3 sec	N/A	30 sec	N/A
Boesch et al., 2017	Bushnell Trophy Cams	N/A	N/A	N/A	N/A	N/A	N/A	1 min	N/A
Bohm and Hofer, 2018	Reconyx HC500, Bushnell Trophy Cam	N/A	N/A	N/A	N/A	No delay	5 pictures	N/A	N/A
Bowkett et al., 2008	CamTrak and Vision Scouting cameras	Infrared	N/A	N/A	N/A	1 min	N/A	N/A	30-50
Boyer-Ontl and Pruetz, 2014	Reconyx PC800 HyperFire	N/A	N/A	N/A	N/A	No delay	3 pictures	N/A	~75
Boyer-Ontl and Pruetz, 2020	Reconyx PC800 HyperFire	N/A	N/A	N/A	N/A	No delay	3 pictures	N/A	~75
Braczkowski et al., 2012	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Braczkowski et al., 2015	DeerCam DC300, Panthera IV	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Braczkowski et al., 2016	Panthera IV	N/A	N/A	N/A	N/A	N/A	N/A	N/A	40
Brandlová et al., 2018	Bushnell 119436 Trophy Cam, Reconyx HC500 HyperFire Semi-Covert IR	I/R in poor light conditions	N/A	N/A	N/A	1 sec	3 pictures	N/A	N/A
Brassine and Parker, 2015	Cuddeback Attack, Bushnell Trophy Cam	N/A	Cuddeback Attack (5 MP)	N/A	N/A	1 min	Bushnell (3 pictures)	Cuddeback (30 sec	~30

								during daytime)	
Broeckhoven and Mouton, 2015	Reconyx PC900 HyperFire	N/A	N/A	N/A	N/A	Timelapse (image every 5 mins)	N/A	N/A	80
Bruce et al., 2018a	Bushnell Aggressor, Reconyx HC500, Cuddeback Long range IR E2	Low glow infrared flash lighting	N/A	N/A	N/A	1-2 sec	3 pictures	N/A	30-45
Bruce et al., 2018b	Cuddeback Long Range IR E2	Ambient light photos and videos (day), Infrared photos and video (night)	N/A	N/A	N/A	N/A	N/A	N/A	30-50
Brzeski et al., 2016	Bushnell Trophy Cam HD	N/A	12 MP	N/A	N/A	N/A	N/A	N/A	N/A
Burt et al., 2021	Cuddeback	Black flash, infrared, white flash	N/A	N/A	N/A	N/A	N/A	N/A	~50
Burton et al., 2011	DeerCam DC-300	N/A	N/A	N/A	N/A	1 min	N/A	N/A	~40
Burton et al., 2012	DeerCam DC-300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~40
Buschke 2016	Bushnell Trophy Trail Camera	N/A	8 MP	N/A	N/A	1 min	N/A	15 sec	N/A
Cardoso et al., 2020	Trophy Cam HD Aggressor No-Glow	N/A	N/A	N/A	N/A	1 sec	N/A	N/A	100-150
Castells et al., 2021	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30-50
Cavada et al., 2019	Xenon flash Cuddeback Ambush, UOVision 565HD IR+	N/A	N/A	N/A	N/A	N/A	N/A	15 sec	30-40
Chapman and Balme 2010	Moultrie Game Spy D40	N/A	N/A	N/A	N/A	1 min	3 pictures	N/A	N/A
Chen et al., 2021	Cuddeback Digital 54307, Reconyx Hyperfire HC 54636	N/A	N/A	N/A	N/A	N/A	3 pictures	N/A	600-1400 (arboreal cameras), ~50 (ground cameras)
Clauss et al., 2021	LTL Acorn 5210A	N/A	N/A	N/A	N/A	60 sec	N/A	N/A	~50
Collen et al., 2011	N/A	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	40
Colyn et al., 2017	Ltl Acorn HD IR	I/R flash	N/A	N/A	N/A	20 sec	3 pictures	N/A	N/A
Colyn et al., 2019	Ltl Acorn 6540MC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Colyn et al., 2020	Ltl Acorn 6540MC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~30-40
Combrink et al., 2016	Bushnell Digital trophy	N/A	3 MP	N/A	N/A	5 min (1 min at the end of the	3 pictures	N/A	30-150

						incubation period)			
Comley et al., 2020	Cuddeback Attack	Strobe flash	5 MP	N/A	N/A	30 sec	N/A	N/A	~45
Connolly et al., 2021	Bushnell Trophy Cam	Infrared	8 MP	N/A	N/A	N/A	N/A	N/A	50-100
Cornhill and Kerley 2020	Bushnell Trophy Cams, Browning Recon Force Camera’s	N/A	N/A	N/A	N/A	1 sec	N/A	20 sec	~50
Coverdale et al., 2016	Bushnell Trophy Cam model #119435	Infrared	N/A	N/A	N/A	N/A	3 pictures burst	N/A	N/A
Cozzi et al., 2015	Cuddeback Expert	N/A	N/A	N/A	N/A	N/A	N/A	N/A	150-200
Crawford et al., 2019	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cronk and Pillay 2019	Bushnell Essential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cronk and Pillay 2020	Bushnell Essential	Infrared	N/A	N/A	N/A	2 sec	2 pictures	N/A	~50-100
Crunchant et al., 2020	Bushnell Trophy Cam	N/A	N/A	N/A	N/A	1 sec	N/A	60 sec	90
Curveira-Santos et al., 2021a	Cuddeback Professional	White-flash	N/A	N/A	N/A	1 sec (daytime), 30 sec (night-time)	N/A	N/A	30
Curveira-Santos et al., 2021b	Pantheracam V4, V5, V6	Xenon flash	N/A	N/A	N/A	N/A	N/A	N/A	30-40
Cusack et al., 2015a	ScoutGuard SG595	N/A	N/A	N/A	N/A	1 min	3 pictures, 1 picture at night during the wet season	N/A	N/A
Cusack et al., 2015b	Reconyx HC500	N/A	N/A	N/A	N/A	No delay	5 pictures	N/A	30
Cusack et al., 2017	Reconyx HC500	N/A	N/A	N/A	N/A	No delay	5 pictures	N/A	30
Davies et al., 2016	ScoutGuard SG550, Bushnell Trophy Cam XLT, UWAY Vigilant Hunter U150	N/A	N/A	N/A	N/A	5 sec	2 pictures	N/A	50-100
Davis et al., 2021a	Cuddeback Models C and F, Bushnell Trophy Cam HD	White-flash (Cuddeback), infrared (Bushnell)	N/A	N/A	N/A	N/A	N/A	N/A	40-60
Davis et al., 2021b	Cuddeback Models C and F, Bushnell Trophy Cam HD	White-flash (Cuddeback), infrared (Bushnell)	N/A	N/A	N/A	N/A	N/A	N/A	40-60
De Beenhouwer et al., 2016	Bushnell	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
De Luca and Rovero 2006	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
de Satgé et al., 2017	Cuddeback Ambush Black Flash 1194	N/A	N/A	N/A	N/A	N/A	N/A	N/A	40

Després-Einspenner et al., 2017	Bushnell Trophy Cam	N/A	N/A	N/A	N/A	1 sec	N/A	60 sec	75-100
Devens et al., 2018	Cuddeback Attack IR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Devens et al., 2021	Cuddeback Attack	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Drouilly and O'Riain 2019	Bushnell Trophy CAM HD	N/A	N/A	N/A	N/A	1 min	3 pictures	N/A	35-40
Drouilly et al., 2018	Bushnell Trophy CAM HD	N/A	N/A	N/A	N/A	1 min	3 pictures	N/A	30-35
du Preez et al., 2014	Cuddeback Capture, Cuddeback Attack	N/A	N/A	N/A	N/A	N/A	Non-baited (1 picture), baited (multiple (unspecified))	N/A	N/A
Dupuis-Desormeaux et al., 2015	Reconyx RC60HO Hyperfire	N/A	N/A	N/A	N/A	N/A	3 pictures, rapid fire	N/A	N/A
Dupuis-Desormeaux et al., 2016a	Reconyx RC60HO Hyperfire	N/A	N/A	N/A	N/A	N/A	3 pictures, rapid fire	N/A	~150
Dupuis-Désormeaux et al., 2016b	Reconyx RC60HO Hyperfire	N/A	N/A	N/A	N/A	N/A	3 pictures, rapid fire	N/A	N/A
Dupuis-Desormeaux et al., 2018	Reconyx HC500 Hyperfire	N/A	N/A	N/A	N/A	N/A	3 pictures, rapid fire	N/A	N/A
Easter et al., 2019	Bushnell Trophy Cam	N/A	24 MP, 14 MP	N/A	N/A	2 sec	2 pictures	N/A	N/A
Easter et al., 2020	Bushnell Trophy Cam	Infrared	24 MP, 14 MP	N/A	N/A	N/A	N/A	N/A	45-60
Easton et al., 2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Edwards et al., 2015	Scoutguard SG560V	N/A	N/A	N/A	N/A	1 min	N/A	N/A	~40
Edwards et al., 2016	Scoutguard SG560V, Reconyx HC600	N/A	N/A	N/A	N/A	1 min (Scoutguard), No delay (Reconyx)	1 picture (Scoutguard), 5 pictures (Reconyx)	N/A	~40
Edwards et al., 2018a	LTI Acorn LTI-5310, Moultrie M-880, Spartan SR1-IR, Scoutguard SG550, Covert Scouting camera 2014 MP8, Ranger Trail camera BN073	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Edwards et al., 2018b	Reconyx PC900 HyperFire	N/A	N/A	N/A	N/A	No delay	3 pictures	N/A	70-90
Edwards et al., 2018c	Panthera Version IV, Reconyx HC 600 HyperFire	N/A	N/A	N/A	N/A	1 sec, no delay	2 pictures, 3 pictures	N/A	N/A
Edwards et al., 2019	Cuddeback X-change	Infrared	20 MP	N/A	N/A	No delay	3 pictures	N/A	~50
Edwards et al., 2020	Cuddeback X-change	Infrared	20 MP	N/A	N/A	1 min	3 pictures	N/A	N/A
Ehlers Smith et al., 2017a	Moultrie M-880	Passive infrared	N/A	N/A	N/A	30 sec	N/A	N/A	15-30
Ehlers Smith et al., 2017b	Moultrie M-880	Passive infrared	N/A	N/A	N/A	30 sec	N/A	N/A	15-30

Ehlers Smith et al., 2017c	Moultrie M-880	Passive infrared	N/A	N/A	N/A	30 sec	N/A	N/A	20-30
Ehlers Smith et al., 2018	Moultrie M-880	Passive infrared	N/A	N/A	N/A	30 sec	N/A	N/A	20-30
Ehlers Smith et al., 2019	Moultrie M-880	Passive infrared	N/A	N/A	N/A	30 sec	N/A	N/A	~30
Ehlers Smith et al., 2020a	Moultrie M-880, Ltl Acorn 6210MC	N/A	N/A	N/A	N/A	60 sec	N/A	N/A	~20
Ehlers Smith et al., 2020b	Moultrie M-880	Passive infrared	N/A	N/A	N/A	30 sec	N/A	N/A	20-30
Elkan et al., 2009	Trailmaster	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Emmet et al., 2021	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Engelbrecht 2016	Ltl Acorn Ltl-6210MC	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Estienne et al., 2017a	Sony Handycam with trailmaster 700V, Scoutguard 550, Bushnell Trophy Cam	N/A	N/A	N/A	N/A	2 min (Sony), 1 sec (Scoutguard 550, Bushnell Trophy Cam)	N/A	Continuous while triggered (Sony), 1 min (Scoutguard 550, Bushnell Trophy Cam)	N/A
Estienne et al., 2017b	Sony Handycam with trailmaster 700V, Scoutguard 550, Bushnell Trophy Cam	N/A	N/A	N/A	N/A	2 min (Sony), 1 sec (Scoutguard 550, Bushnell Trophy Cam)	N/A	Continuous while triggered (Sony), 1 min (Scoutguard 550, Bushnell Trophy Cam)	N/A
Estienne et al., 2019	Sony Handycam with trailmaster 700V, Scoutguard 550, Bushnell Trophy Cam	N/A	N/A	N/A	N/A	2 min (Sony), 1 sec (Scoutguard 550, Bushnell Trophy Cam)	N/A	Continuous while triggered (Sony), 1 min (Scoutguard 550, Bushnell Trophy Cam)	N/A
Etana et al., 2021	Browning Strike Force Elite HD	Digital infrared	N/A	N/A	N/A	60 sec	N/A	20 sec	40-60
Everatt et al., 2015	Reconyx HC500, Spy Point Tiny-W2, Bushnell Trophy Cam	N/A	N/A	0,97 (Reconyx HC500), 0,91 (Spy Point Tiny-W2), 0,66 (Bushnell Trophy Cam)	~24 (Reconyx HC500), ~17 (Spy Point Tiny-W2), ~18 (Bushnell Trophy Cam)	N/A	N/A	N/A	N/A

Evrard et al., 2019	Bushnell TC Aggressor	Infrared	N/A	N/A	N/A	N/A	3 pictures	30 sec (Last week of observations)	~4000 (Canopy)
Fabiano et al., 2020	Flash Cuddeback DeerCam DC200 (used from 2005-2009), Bushnell Trophy Cam (used from 2010-2014), Moultrie M60 (used in 2008)	N/A	5 MP	N/A	N/A	30 sec	3 pictures burst	N/A	~75
Farris et al., 2014	Moultrie D40, Reconyx PC85, Cuddeback IR, DeerCam DC300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20-30
Farris et al., 2016a	Reconyx PC85 and HC500, Moultrie D50 and D55, Cuddeback Infra Red, DeerCam DC300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20-30
Farris et al., 2016b	Reconyx PC85 and HC500, Moultrie D50 and D55, Cuddeback Infra Red, DeerCam DC300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20-30
Farris et al., 2017	Reconyx PC85 and HC500, Moultrie D50 and D55, Cuddeback Infra Red, DeerCam DC300	N/A	N/A	N/A	N/A	N/A	3 pictures	N/A	10-30
Faure et al., 2021	Reconyx HC500, HC600, Bushnell Trophy Camera	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~40
Fink et al., 2020	Bushnell Trophy Cam Model #119636C	Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	20-30
Fležar et al., 2019	Bushnell Trophy Cam HD	Passive infrared	N/A	N/A	N/A	1 sec	N/A	30 sec	~30
Fonteyn et al., 2021	Bushnell Trophy Cam HD	N/A	N/A	N/A	N/A	1 sec	N/A	5 sec	30-50
Fotang et al., 2021	LTL-5310A Acorn	N/A	1 080 pixels	N/A	N/A	N/A	N/A	60 sec	30-80
Freeman et al., 2014	ScoutGuard 550V, ScoutGuard SG550, Wildview STC-TGL3IR	Passive infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuda et al., 2018	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	40
Garriga et al., 2019	Reconyx HC500, HC600, PC800	Infrared	3,1 MP	N/A	N/A	No delay	3 pictures	N/A	N/A
Gaugris et al., 2021	Bushnell, Uway, Cuddeback	Passive Infrared	5 MP	N/A	N/A	30 sec	3 pictures	N/A	60-80
Gaynor et al., 2018	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gaynor et al., 2021	Bushnell TrophyCam	N/A	N/A	N/A	N/A	30 sec	2 pictures	N/A	100
Gebert et al., 2019	Bushnell Trophy Cam HD Essential model 119736	Infrared	N/A	N/A	N/A	10 sec	N/A	20 sec	N/A
Gebert et al., 2020	Bushnell Trophy Cam HD Essential	Infrared	N/A	N/A	N/A	10 sec	N/A	20 sec	70-140
Gerber et al., 2010	DeerCam DC300	N/A	N/A	N/A	N/A	30 sec	N/A	N/A	30
Gerber et al., 2012	Deercam DC300, Reconyx PC85	Passive infrared	N/A	N/A	N/A	N/A	N/A	N/A	20
Gessner et al., 2014	Reconyx hyperfire HC500	Infrared	N/A	N/A	N/A	No delay	N/A	N/A	30-50
Gil-Sánchez et al., 2020	N/A	Passive infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gil-Sánchez et al., 2021	Moultrie M-999I	Passive infrared	N/A	N/A	N/A	3 images every 10 seconds	N/A	N/A	N/A
Giordano et al., 2017	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Greco and Rovero 2021	Browning, Cuddleback, UOVision	Infrared	N/A	0.15 (Browning), 1-2 (Cuddleback and UOVision)	N/A	N/A	N/A	N/A	~50
Greco et al., 2021	Moultre I40 Digital Game Camera, DeerCam DC100, StealthCam MC2-GV, Trailmaster TM 1550	Infrared	N/A	N/A	N/A	60 sec (digital), 8 min (film)	N/A	N/A	N/A
Green et al., 2018	Bushnell HD	N/A	N/A	N/A	N/A	N/A	3 pictures	N/A	N/A
Grey et al., 2013	Cuddeback Expert Digital Scouting Cameras	N/A	N/A	N/A	N/A	1 min	N/A	N/A	40
Gueye et al., 2021	Dörr Mini Black 5.0, Moultrie M-888i, L50	Infrared	N/A	N/A	N/A	15 sec (Dörr), 10 sec (Moultrie)	3 pictures	N/A	50-70
Gumede et al., 2020	Moultrie M-880, Cuddeback	N/A	20 MP	N/A	N/A	30 sec	N/A	N/A	15-30
Hanekom and Randall 2015	Bushnell Trophy Cams, Cuddeback Capture	infrared (Bushnell), incandescent (Cuddeback)	N/A	N/A	N/A	N/A	N/A	N/A	~35
Hanke and Dickman 2013	Moultrie I40 Digital Game Cameras	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hardouin et al., 2021	Cuddeback Professional Color Model 1347, Cuddeback X-Change Color Model 1279, Reconyx HyperFire HC500	Xenon flash	N/A	N/A	N/A	N/A	N/A	N/A	~40
Hart et al., 2016	Ltl Acorn 5210MG, 6210MG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Haurez et al., 2015	GameSpy Moultrie M-80XT	N/A	N/A	N/A	13.5 ± 1.5	No delay	N/A	N/A	N/A
Hausser et al., 2017	Cuddeback Capture	Passive infrared	3,0 MP	N/A	N/A	1 min	N/A	N/A	N/A
Havmøller et al., 2019	Xenon flash Cuddeback Ambush, UOVision 565HD IR+	Passive infrared, white flash	N/A	N/A	N/A	N/A	N/A	15 sec	30-40
Havmøller et al., 2020	Xenon flash Cuddeback Ambush, UOVision 565HD IR+	Passive infrared, white flash	N/A	N/A	N/A	N/A	N/A	15 sec	30-40
Hayward and Hayward 2012	N/A	N/A	N/A	N/A	N/A	30 sec, 60 sec	N/A	N/A	N/A
Head et al., 2012	Scoutguard 550, Bushnell Trophy Cam	N/A	N/A	N/A	N/A	No delay	N/A	60 sec	N/A
Head et al., 2013	Scoutguard 550, Bushnell Trophy Cam	N/A	N/A	N/A	N/A	No delay	N/A	60 sec	N/A
Hedwig et al., 2018	Bushnell Trophy Cam 119405, 119436, Bushnell Trophy Cam HD 119547, 119437, 119476, 119676, 119678, 119776, Bushnell Trophy Cam Security 119466, Reconyx HC 500 hyperfire semi-covert IR	N/A	N/A	N/A	N/A	No delay, 3 sec if taking pictures	10 pictures	60 sec	~60
Hegerl et al., 2017	UOVision IR+, UOVision Technology	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Henschel et al., 2011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Henschel et al., 2014	DeerCam 200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~45

Hobbhahn and Johnson 2015	Bushnell HD Trophy Cam 119476 and 119577	N/A	N/A	N/A	N/A	N/A	N/A	60 sec	N/A
Holdo et al., 2020	HCO Scoutguard trail cameras	LED flashes	N/A	N/A	N/A	N/A	N/A	N/A	150
Hongo et al., 2016	Bushnell Trophy Cam 2010	N/A	N/A	N/A	N/A	30 sec	N/A	30 sec or 60 sec	30
Hongo et al., 2018	Bushnell Trophy Cam 2010	N/A	N/A	N/A	N/A	30 sec	N/A	30 sec or 60 sec	30
Houngbégnon et al., 2020	Bushnell Trophy Cam HD, Moultrie Game Spy	Passive infrared	N/A	N/A	N/A	1-3 sec	1-3 pictures	N/A	~30
Howes-Whitecross et al., 2020	Little Acorn 6310WMG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50
Isbell and Bidner 2016	Reconyx Hyperfire PC900, Rapidfire RM45	Infrared	N/A	N/A	N/A	N/A	3 pictures	N/A	N/A
Isbell et al., 2017	Reconyx Hyperfire PC900, Rapidfire RM45	Infrared	N/A	N/A	N/A	N/A	3 pictures	N/A	N/A
Janecke 2021	Bushnell, Cuddeback, Scoutguard	Infrared	N/A	N/A	N/A	5 sec, image every 5 mins	2 pictures	N/A	~50-170
John Power et al., 2021	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Johnson and Van der Niet 2019	Bushnell Trophy Cam 119466, Bushnell Nature View 119740	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jooste et al., 2013	Moultrie I40	Digital infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jůnek et al., 2015	Ltl Acorn 5210MC	Infrared	5 MP	N/A	N/A	No delay	N/A	N/A	100-150
Kane et al., 2015	N/A	N/A	N/A	N/A	N/A	60 sec (digital cameras), 30 sec (film cameras)	2 pictures (digital cameras), 1 picture (film cameras)	N/A	30-40
Karssene et al., 2019a	Moultrie M-990i	Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	30-40
Karssene et al., 2019b	Bushnell Trail Scout	Infrared	2,1 MP	N/A	N/A	30 sec	N/A	N/A	30-40
Kauffman et al., 2007	Camtrak	Infrared	N/A	N/A	N/A	3 min	N/A	N/A	N/A
Kavwele et al., 2017	Reconyx Rapidfire RM45	Infrared	N/A	N/A	N/A	No delay	N/A	N/A	50
Kely et al., 2021	Bushnell	Passive infrared	5 MP	N/A	N/A	1 sec	N/A	60 sec	150
Kent and Hill 2013	Cuddeback Digital Expert	N/A	N/A	N/A	N/A	1 min	N/A	N/A	25-40
Kheswa et al., 2018	Moultre M880	Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	~30
Kiepiel and Johnson 2019	Bushnell 14 Mp NatureView Cam HD	N/A	14 MP	N/A	N/A	10 sec	N/A	30 sec	N/A
Kinnaird and O'Brien 2012	Deercam, Reconyx RM45, DLC Covert SG550	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Koeppel et al., 2020	Lynx Optics Ranger Trail Cameras	Infrared	N/A	N/A	N/A	5 sec	3 pictures	N/A	N/A
Koopmans et al., 2021	Cuddeback E2, Reconyx Hyperfire HC500, HC800, Reconyx PC800	Passive infrared	N/A	N/A	N/A	N/A	3 pictures burst	N/A	70

Kühn et al., 2017	Bushnell Trophy Cam HD Max-Colour LCD model 119577C and model 119466	N/A	N/A	N/A	N/A	10 sec	N/A	60 sec	N/A
Lacroux et al., 2019	Reconyx XR-6 Ultrafire, Bushnell Trophy Cam HD Max	N/A	1280 × 720 pixels	N/A	21 m (Reconyx), 18 m (Bushnell)	5 sec	N/A	30 sec (Reconyx), 60 sec (Bushnell)	~100
LaFleur et al., 2014	Moultrie Game Spy I-40	Infrared	N/A	N/A	N/A	30 sec	3 pictures	N/A	N/A
Laguardia et al., 2021	Bushnell Trophy Cam HD	Passive infrared	N/A	N/A	N/A	N/A	N/A	N/A	100-120
Lapuente et al., 2017	Bushnell HD trophy cam 119437	Infrared	N/A	N/A	N/A	N/A	N/A	60 sec	N/A
Lapuente et al., 2020a	Bushnell HD trophy cam 119437, Bushnell HD Aggressor, Browning SPEC-OPS	Passive Infrared	N/A	N/A	N/A	N/A	N/A	60 sec	N/A
Lapuente et al., 2020b	Bushnell HD trophy cam, Browning SPEC-OPS	Passive Infrared	N/A	N/A	N/A	N/A	N/A	60 sec	N/A
Laudisoit et al., 2021	Bushnell	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30-60
Lhoest et al., 2020	Trophy Cam HD Aggressor	N/A	N/A	N/A	N/A	N/A	3 pictures	N/A	30-50
Lombardi et al., 2017	Bird Cam 2.0 8 MP, Bushnell 119466	N/A	8 MP (Bird Cam)	N/A	N/A	N/A	N/A	N/A	N/A
Loock et al., 2018	Reconyx Hyperfire HC600	N/A	N/A	N/A	N/A	60 sec	N/A	N/A	50
Loveridge et al., 2020	Cuddeback 1125, 1149, C1, Panthera V4, Panthera Stealthcam G42NG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Majelantle et al., 2021	PRIMOS ProofCam 3	N/A	N/A	N/A	N/A	30 sec	3 picture burst	N/A	20-100
Mann et al., 2015	Cuddeback Capture	N/A	N/A	N/A	N/A	60 sec	N/A	N/A	~40
Mann et al., 2019	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mann et al., 2020	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mapendere et al., 2021	Bushnell Trophy Cam, ScoutGuard	N/A	N/A	N/A	15 (ScoutGuard)	1 sec	N/A	10 sec (ScoutGuard)	30-50, 150-200
Maphalala and Monadjem 2017	Primos Truth Cam 35 model 63010	N/A	N/A	N/A	N/A	10 sec	N/A	N/A	N/A
Maputla et al., 2013	Cuddeback EXcite C2000, Reconyx RM 45	Infrared	N/A	N/A	N/A	1 min	N/A	N/A	N/A
Marnewick et al., 2006	Trailmaster	Infrared	N/A	N/A	N/A	20 sec	N/A	N/A	~50
Marnewick et al., 2008	TrailMaster TM 1550	Infrared	N/A	N/A	N/A	20 sec	N/A	N/A	50
Marracoli et al., 2019	Bushnell 119435, 119476 and 119678	N/A	N/A	N/A	N/A	N/A	N/A	N/A	45
Martin et al., 2015	Reconyx RM 45 and HC 500	Infrared flash	N/A	N/A	N/A	No delay	N/A	N/A	50
Martin et al., 2017	Reconyx RM 45 and HC 500	Infrared flash	N/A	N/A	N/A	No delay	N/A	N/A	50
Martínez-Íñigo et al., 2021	Bushnell Trophy Cam HD	N/A	N/A	N/A	N/A	1 sec	N/A	60 sec	N/A
Martins and Harris 2013	N/A	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	40

Maseko et al., 2017	Moultre M880	Passive Infrared	N/A	N/A	N/A	N/A	N/A	N/A	30
Masiaine et al., 2021	N/A	N/A	N/A	N/A	N/A	5 sec	N/A	N/A	~40-50
Mateo-Tomás et al., 2017	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mayengo et al., 2020	Reconyx HC600 Hyperfire, Bushnell	Infrared	N/A	N/A	N/A	1 image per sec when triggered	N/A	N/A	40
McCarthy et al., 2021	Bushnell Trophy Cam Model #119576C	N/A	N/A	N/A	N/A	1 sec	N/A	60 sec	N/A
McCollum et al., 2017	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
McCollum et al., 2018	Moultrie Game Spy	N/A	N/A	N/A	N/A	10 sec	2 pictures	N/A	N/A
McPherson et al., 2016	Ltl Acorn 5210MG and 6210MG	N/A	N/A	N/A	N/A	Timelapse 1 image/ minute and 1 image/ 2 minutes	N/A	N/A	N/A
Merson et al., 2019	Cuddeback Ambush IR 1187	Infrared	N/A	N/A	N/A	Photo every 5 seconds	N/A	N/A	~30
Merson et al., 2020	Cuddeback Ambush IR 1187	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20-30
Mertens et al., 2020	Bushnell Trophy Cam 2011, model 119436, Bushnell Trophy Cam XLT 2011, model 119456	Infrared	1 280 x 720 video resolution	N/A	10	No delay	N/A	30 sec	~60
Mhlanga et al., 2018	Moultrie M880, Ltl Acorn 6210MC	Passive Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	~45
Miller et al., 2018	PantheraCam V-series	N/A	N/A	N/A	N/A	8 sec	N/A	N/A	~40
Mills and Harris 2020	Reconyx PC800, PC850, PC900	Infrared, white-flash	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mills et al., 2019a	Pantheracam v. 4, Deercam DC300, CamTrakker Ranger, Recon Digital Pro Scouting Camera, Stealth Cam HD, Cuddeback Capture IR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25
Mills et al., 2019b	Pantheracam v4, Deercam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25
Mills et al., 2020	Reconyx PC800, PC850, PC900	White-flash, infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mokotjomela and Hoffmann 2013	Scoutguard SG550V-31	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Monterroso et al., 2020	Hyperfire HC600, HF2X Hyperfire 2, Cuddeback Model 1231	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Moolman et al., 2019	Bushnell Trophy Cam HD Aggressor No Glow	Infrared	8 MP	N/A	N/A	1 sec (pictures), 2 sec (videos)	N/A	15-30 sec	100-150
Moore et al., 2020	Reconyx PC800 Hyperfire, HC500 Hyperfire semi-covert, HC600 Hyperfire	Infrared	N/A	N/A	N/A	No delay	3 pictures	N/A	60-150 (ground cameras), 400-1700

									(arboreal cameras)
Morris et al., 2021	Cuddeback Professional Colour Model 1347	Strobe flash	N/A	N/A	N/A	N/A	N/A	N/A	35-40
Morrison et al., 2020	Bushnell Trophy Cam, Reconyx	N/A	N/A	N/A	N/A	N/A	N/A	30 sec	N/A
Moupela et al., 2014	Moultrie L55 IR automatic cameras	Infrared	N/A	N/A	N/A	4 pictures per minute	N/A	30 sec	80
Msuha et al., 2012	DeerCam 300	Passive Infrared	N/A	N/A	N/A	1 min	N/A	N/A	~40
Mugerwa et al., 2013	Reconyx RM45	N/A	1,3 MP	N/A	N/A	1 sec	N/A	N/A	50
Mugerwa et al., 2017	Cuddeback Capture, Cuddeback Attack	N/A	N/A	N/A	N/A	30 sec	N/A	N/A	N/A
Muneza et al., 2019	Reconyx HyperFire HC500, ScoutGuard SG565	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Murphy et al., 2017	DeerCam DC300, Cuddeback IR, Reconyx PC85 and HC500, Moultrie D50 and D55	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20-30
Murphy et al., 2018a	DeerCam DC300, Reconyx PC85 and HC500, Moultrie D50 and D55, Cuddeback IR, HCO Scoutguard SG565FV	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10-30
Murphy et al., 2018b	DeerCam DC300, Reconyx PC85 and HC500, Moultrie D50 and D55, Cuddeback IR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20-30
Murphy et al., 2019	DeerCam DC300, Reconyx PC85 and HC500, Moultrie D50 and D55, Cuddeback IR, HCO Scoutguard SG565FV	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20-30
Nakashima 2015	Bushnell Trophy Cam 2010	N/A	N/A	N/A	N/A	N/A	N/A	30 sec	30
Nakashima et al., 2013	Bushnell Trophy Cam 2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30
Nakashima et al., 2020	Bushnell Trophy Cam 2010	N/A	N/A	N/A	N/A	N/A	N/A	30 sec	30
Ndlovu et al., 2018	Bushnell Nature view HD	N/A	12 MP	N/A	N/A	N/A	N/A	N/A	N/A
Ngama et al., 2018a	Reconyx Rapidfire RC55	N/A	N/A	2 sec	N/A	N/A	N/A	N/A	~150
Ngama et al., 2018b	Reconyx Rapidfire RC55	N/A	N/A	N/A	N/A	1 image every 2 seconds when triggered	N/A	N/A	150
Nghikembua et al., 2020	Bushnell Trophy Cam, Spypoint BF10 HD	N/A	N/A	N/A	N/A	10 sec	N/A	N/A	N/A
Niang and Ndiaye 2021	Bushnell Trophy Cam HD Essential	Passive Infrared	N/A	0.3	N/A	N/A	N/A	N/A	N/A
Nichols and Alexander 2018	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Noack et al., 2019	Cuddeback X-change model 1279	White-flash	5 MP	N/A	N/A	No delay	3 pictures	N/A	~175
Nyiramana et al., 2011	Reconyx RapidFire RM45	Infrared	1,3 MP	N/A	N/A	N/A	3 pictures	N/A	N/A
Oberosler et al., 2020a	Reconyx HC500, Cuddeback Ambush	Infrared flash (Cuddeback)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oberosler et al., 2020b	Reconyx RC45 and HC500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

O'Brien and Kinnaird 2011	DeerCam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O'Brien et al., 2020	Reconyx RM45 Rapidfire IR, HC500 and HC600 Hyperfire Semi-Covert IR, PC800 and PC900 Hyperfire Professional IR, Bushnell Trophy Cam HD 119437	Infrared	N/A	0,2 - 1	N/A	N/A	3 pictures	N/A	50-60
Olson et al., 2012	Reconyx HyperFire PC800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	600-800
Omeja et al., 2016	Reconyx HyperFire PC800 Professional Semi-Covert IR	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orban et al., 2018	Bushnell Trophycam	Passive Infrared	5 MP	1	N/A	30 sec	3 pictures	N/A	40-60
Padayachee et al., 2021	Bushnell Trophy Cam HD	N/A	8 MP	N/A	N/A	N/A	N/A	N/A	N/A
Page-Nicholson et al., 2018	Cuddeback	Passive Infrared	N/A	N/A	N/A	N/A	N/A	N/A	400
Palmer and Packer 2018	Scoutguard SG565, DLC Covert Reveal	Passive Infrared	N/A	N/A	14	60 sec	3 pictures	N/A	~50
Patterson et al., 2016	Ltl Acorn 6210MMX	Passive Infrared	N/A	N/A	20	10 sec	3 pictures	30 sec	N/A
Paúl et al., 2020	ScoutGuard SG550	Infrared	720x480	1	N/A	N/A	N/A	N/A	~150
Payne et al., 2018	Bushnell Trophy Cam	Infrared	N/A	1	N/A	N/A	N/A	10 sec	30-50, 150-200
Payne et al., 2019	N/A	N/A	N/A	N/A	N/A	3 sec	N/A	N/A	N/A
Pebsworth et al., 2012	Covert SG550	Infrared	N/A	N/A	N/A	1 sec	N/A	59 sec	~20
Pebsworth et al., 2019	Bushnell Trophycam	Infrared	N/A	N/A	N/A	1 sec	N/A	59 sec	~20
Pebsworth et al., 2020	Bushnell Trophycam	Infrared	N/A	N/A	N/A	1 sec	N/A	59 sec	~20
Penny et al., 2021	Bushnell Trophy Cam Essential and Aggressor, Ltl Acorn 5610WA	Passive infrared	N/A	N/A	N/A	10 sec	N/A	30 sec	N/A
Pettorelli et al., 2010	Deercam 300	Passive Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	30-40
Pinto et al., 2016	Stealth Prowler DVIR5, TrailMaster TM1500 and TM1550	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pirie et al., 2016	Little Acorn 5210A	N/A	N/A	N/A	15	30 sec	3 pictures	N/A	N/A
Pozo et al., 2019	Bushnell Trophy Cam HD, Reconyx HC500	Infrared	N/A	N/A	N/A	N/A	3 pictures	N/A	~100
Puls et al., 2021	Cuddeback Ambush Black Flash 1194	N/A	N/A	N/A	N/A	60 sec	N/A	N/A	40
Ramesh and Downs 2013	Ltl Acorn 6210MC	Passive Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	20
Ramesh and Downs 2014a	Ltl Acorn 6210MC	Passive Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	20
Ramesh and Downs 2014b	Ltl Acorn 6210MC	Passive Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	20
Ramesh and Downs 2015	Ltl Acorn 6210MC	Passive Infrared	N/A	N/A	N/A	N/A	N/A	N/A	20

Ramesh et al., 2016a	Ltl Acorn 6210MC	Passive Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	20
Ramesh et al., 2016b	Ltl Acorn 6210MC, Moultre M880	Passive Infrared	N/A	N/A	N/A	60 sec	N/A	N/A	20
Ramesh et al., 2017a	Ltl Acorn 6210MC, Moultre M880	Passive Infrared	N/A	N/A	N/A	N/A	N/A	N/A	20
Ramesh et al., 2017b	Ltl Acorn 6210MC, Moultre M880	Passive Infrared	N/A	N/A	N/A	60 sec	N/A	N/A	20
Ramnanan et al., 2013	Moultrie 140, Trailmaster TM1550, DeerCam DC100, Stealth Cam MC2-GV	Infrared, flash film	N/A	N/A	N/A	60 sec (digital cameras), 10 min (film cameras)	N/A	N/A	N/A
Rasambainarivo et al., 2017	Moultrie M880	N/A	N/A	N/A	N/A	10 sec	3 pictures	N/A	10-20
Razafindratsima 2017	ScoutGuard SG56FV	N/A	5 MP	N/A	N/A	N/A	3 pictures	N/A	10-20
Reece et al., 2021	Cuddeback X-Change Model 1279	Strobe flash	N/A	N/A	N/A	60 sec	3 pictures	N/A	50
Rich et al., 2016	Panthera v4, Bushnell Trophy Cam	Infrared	N/A	N/A	N/A	30 sec	3 pictures	N/A	N/A
Rich et al., 2017a	Panthera v4, Bushnell Trophy Cam	Infrared	N/A	0.18 (Pantera v4), 0.3 (Bushnell Trophy Cam)	N/A	30 sec	3 pictures	N/A	N/A
Rich et al., 2017b	Leaf River, TrailMAC, Moultrie, Reconyx, Bushnell, Panthera, DeerCam, CamTrak, Cuddeback, Bushnell	White flash, infrared	N/A	N/A	N/A	N/A	Varied from 1-5	N/A	Varied between 10-1000
Rich et al., 2019	Panthera v4, Bushnell Trophy Cam	Incandescent-flash (Panthera), infrared (Bushnell Trophy Cam)	N/A	0.18 (Pantera v4), 0.3 (Bushnell Trophy Cam)	N/A	30 sec	3 pictures	N/A	N/A
Rich et al., 2020	Recony Hyperfire PC800	Infrared	N/A	N/A	N/A	30 sec	3 pictures	N/A	N/A
Rodrigues et al., 2021	Bushnell Trophy Cam	N/A	N/A	N/A	N/A	N/A	3 pictures	N/A	N/A
Roesch et al., 2021	Browning Dark Ops HD	N/A	N/A	N/A	N/A	30 sec timelapse	N/A	N/A	N/A
Roque et al., 2021	Foxelli Outdoor Gear Oak’s Eye Trail Cam	N/A	14 MP	N/A	N/A	60 sec	2 picture burst	N/A	50-150
Rosenblatt et al., 2016	Reconyx Hyperfire PC800	N/A	N/A	N/A	N/A	N/A	5 pictures	N/A	N/A
Ross et al., 2020	Moultrie M888, M880, D55, A35, WGI Terra Extreme, Bushnell Trophy Cam HD, HCO-SG565, Stealth Cam ZX3	N/A	N/A	N/A	N/A	N/A	3 pictures	N/A	10-20
Rottstock et al., 2020	Stealth Cam G45NG PRO HD	Infrared	N/A	N/A	N/A	30 sec	5 pictures burst	N/A	100

Rovero and Marshall 2009	CamTrak, Vision Scouting	Infrared	N/A	N/A	N/A	60 sec	N/A	N/A	N/A
Rovero et al., 2005	CamTrak, Trailmaster	Infrared	N/A	N/A	N/A	20 - 30 sec	N/A	N/A	N/A
Rovero et al., 2008	Vision Scouting	N/A	N/A	N/A	N/A	60 sec	N/A	N/A	N/A
Rovero et al., 2013	Vision Scouting, Deercam, Kodak 200 ISO, Reconyx RM45	N/A	N/A	N/A	N/A	Minimum 60 sec, no delay	N/A	N/A	~50
Rovero et al., 2014	Reconyx RM45	N/A	N/A	N/A	N/A	No delay	N/A	N/A	~50
Rovero et al., 2017	Deercam DC300	N/A	N/A	N/A	N/A	Minimum 60 sec	N/A	N/A	~50
Santangeli et al., 2020	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Satterfield et al., 2017	Moultrie M80 Game Spy	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Schäfer et al., 2019	BestoU Model 16	Infrared	16 MP	N/A	N/A	Timelapse (images every 20 sec)	N/A	N/A	140
Schumann et al., 2006	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Schwabe et al., 2015	Moultrie Game Spy M-100	Passive Infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Searle et al., 2021a	Cuddeback Professional Color Model 1347, X-Change Color Model 1279, Reconyx HyperFire HC500	Xenon flash	N/A	N/A	N/A	N/A	N/A	N/A	30-40
Searle et al., 2021b	Cuddeback Professional Color Model 1347, X-Change Color Model 1279, Reconyx HyperFire HC500	Xenon flash	N/A	N/A	N/A	N/A	N/A	N/A	30-40
Seufert et al., 2010	Wildview Xtreme 2	N/A	N/A	N/A	N/A	3-8 sec	3 pictures	N/A	100
Sever 2021	Bushnell Trophy camera Model # 4119438, # 119436	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~90-170
Sillero-Zubiri et al., 2015	Reconyx PC800 and PC60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	40
Simo et al., 2020	Cuddeback X Change Colour Model 1279, Long-range IR E2 Model; Bushnell Trophy Camera Brown 119836, Trophy Cam HD 119875C	N/A	N/A	N/A	N/A	N/A	3 pictures	N/A	30-40
Simon et al., 2020	Bushnell Trophy HD Aggressor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30
Smit et al., 2019	Cuddeback Capture	Incandescent flash	N/A	N/A	N/A	30 sec	N/A	N/A	300
Sogbohossou et al., 2018	Bushnell Trophy Cam 11-9636, Browning Dark Ops HD, Moultrie M880i, M-990i	Passive Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	~40
Soiret et al., 2019	Bushnell Trophy Cam 119875	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Soto-Shoender et al., 2018	Primos Truth Cam 35, Primos Hunting	N/A	N/A	N/A	N/A	N/A	N/A	N/A	40-60
Ssali and Sheil 2019	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ssali et al., 2018	Reconyx RM45	N/A	N/A	N/A	N/A	1 sec	N/A	N/A	N/A
Stanton-Jones et al., 2018	Bushnell Trophy Cam HD 119577	N/A	N/A	N/A	N/A	Timelapse (image every 60 sec)	N/A	N/A	N/A

Stein et al., 2008	Deercam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	60-100
Stein et al., 2010	Deercam	Passive Infrared	N/A	N/A	N/A	N/A	N/A	N/A	70-170
Stein et al., 2011	Deercam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~70
Steinbeiser et al., 2019	LTL Acorn 5210A	N/A	N/A	N/A	N/A	60 sec	N/A	N/A	~50
Stommel et al., 2016a	Reconyx PC800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stommel et al., 2016b	Reconyx PC800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Strampelli et al., 2018	N/A	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Strampelli et al., 2020	Reconyx HC500, Spy Point Tiny-W2, Bushnell Trophy Cam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	35
Strampelli et al., 2021	Cuddeback Professional Color Model 1347, X-Change Color Model 1279, Reconyx HyperFire HC500	Xenon flash	N/A	N/A	N/A	N/A	N/A	N/A	30-40
Stratford et al., 2020	Reconyx RC55	N/A	N/A	N/A	N/A	1 image per second for 10 seconds when triggered. 15-30 second delay between triggers	N/A	N/A	N/A
Sutherland et al., 2018	Primos Proof Cam 03 HD Trail Camera Model No. 63056	Infrared	N/A	N/A	N/A	60 sec	2 pictures	N/A	40
Swanepoel et al., 2015	Moultrie I40, Trailmasters TM 1550, DeerCam DC100, Stealth Cam MC2-GV	Infrared, film	N/A	N/A	N/A	60 sec (digital cameras), 8 min (film cameras)	N/A	N/A	50
Swanson et al., 2015	Scoutguard SG565, DLC Covert II, DLC Covert Reveal	Passive Infrared	N/A	N/A	~14	60 sec	1-3 pictures	N/A	~50
Swanson et al., 2016	N/A	N/A	N/A	N/A	~15	N/A	N/A	N/A	~50
Symes 2017	Bushnell 119456	N/A	N/A	N/A	N/A	3 sec	3 pictures	N/A	~150
Tambling et al., 2013	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tambling et al., 2015	ScoutGuard 550V and SG550, Wildview STC-TGL3IR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tarugara et al., 2019a	Cuddeback C2	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tarugara et al., 2019b	Cuddeback C2	Infrared	5 MP	N/A	N/A	Minimum 60 sec	N/A	N/A	N/A
Tarugara et al., 2021	Cuddeback C2	Infrared	N/A	N/A	N/A	60 sec	N/A	N/A	N/A
Thompson et al., 2017a	Ltl Acorn 6210MC, Bushnell NatureView HD Live View, ProStalk PC4000	Infrared	N/A	0.8 (Ltl Acorn 6210MC and	N/A	Time lapse (1 image every	3 pictures burst	N/A	N/A

				ProStalk PC4000), 0.2 (Bushnell NatureView HD Live View)		5 mins), set to motion detect with a 3 min delay after breeding season			
Thompson et al., 2017b	Ltl Acorn 6210MC, Bushnell NatureView HD Live View	N/A	N/A	N/A	N/A	Time lapse (1 image every 5 mins), set to motion detect with a 3 min delay after breeding season	N/A	10 sec recordings at one camera site	N/A
Thorn et al., 2009	DeerCam DC300, Camtrakker	N/A	N/A	N/A	N/A	5 min	N/A	N/A	45
Thorn et al., 2011	N/A	Passive Infrared	N/A	N/A	N/A	N/A	N/A	N/A	~45
Tichagwa et al., 2020	Bushnell TrophyCam	Infrared	8 MP	N/A	N/A	4 sec	N/A	N/A	100
Torrents-Ticó et al., 2017	Panthera v4, Bushnell TrophyCam	Infrared (Bushnell), incandescent (Panthera v4)	N/A	0.18 (Panthera v4), 0.3 (Bushnell TrophyCam)	N/A	30 sec	3 pictures (infrared cameras), 1 picture (white flash cameras)	N/A	~50
Torrents-Ticó et al., 2021	Bushnell Trophy Cam	Infrared	N/A	N/A	N/A	N/A	3 pictures	N/A	90-100
Tosso et al., 2018	Moultrie M-990i	N/A	N/A	N/A	N/A	4 images/min	N/A	30 sec	N/A
Treves et al., 2010	Camtrakkers	Film	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tshabalala et al., 2021	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Turikunkiko et al., 2021	Reconyx Hyperfire PC800	Infrared	N/A	N/A	N/A	No delay	3 pictures	N/A	50
Turner and Midgley 2016	Ltl Acorn Ltl-6210M HD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Turner et al., 2014	Reconyx RC55 Rapidfire, PC 800 Hyperfire	N/A	N/A	N/A	N/A	No delay. 1 image per second for 10 seconds when triggered	N/A	N/A	120
van Berkel et al., 2019	Bushnell Trophy Cam HD 2012, 2015 models, Aggressor HD 2016	N/A	N/A	N/A	N/A	No delay	3 pictures	N/A	~40
van Blerk et al., 2017	Little Acorn Ltl-5210A	N/A	N/A	N/A	N/A	N/A	N/A	2 mins	N/A

van der Meer et al., 2018	Ltl Acorn 5210MG, 6210MG	N/A	N/A	N/A	N/A	Time lapse (1 image per min). After ringing time lapse was 1 image/2min	N/A	N/A	N/A
Van der Weyde et al., 2018	Bushnell Aggressor, Bushnell Trophy Cam	Infrared	N/A	N/A	N/A	30 sec	3 pictures burst	N/A	~60
Van der Weyde et al., 2021	Bushnell Trophy Cam HD, Bushnell Aggressor	N/A	N/A	N/A	N/A	30 sec	N/A	N/A	N/A
van Leeuwen et al., 2020	Bushnell Trophy Cam XLT, PixController DVREye, TrailMaster TM700v	Passive Infrared	8 MP (Bushnell Trophy Cam)	N/A	N/A	1 sec	N/A	60 sec	N/A
Van Opstal et al., 2019	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
van Pinxteren et al., 2018	Bushnell Trophy Cam model #119576C and #119476	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30-160
Vanthomme et al., 2013	Reconyx RC55 Rapidfire	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~50
Veldhuis et al., 2020	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~40
Verschueren et al., 2021a	Cuddeback, DeerCam DC200, Bushnell Trophy Cam	Infrared	N/A	N/A	N/A	30 sec	3 picture burst	N/A	~75
Verschueren et al., 2021b	Bushnell Trophy Cam	N/A	5 MP	N/A	N/A	30 sec	3 picture burst	N/A	50-70
Vink et al., 2020	Bushnell Trail Cam	N/A	N/A	N/A	N/A	1 sec	N/A	60 sec	~100
Vinks et al., 2021	Reconyx Hyperfire PC800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vissia et al., 2021	Bushnell Trophy Cam HD Essential E3, Crenova RD 1000 Trail Hunting Camera	N/A	16 MP	N/A	N/A	5 sec	3 pictures	N/A	40-60
Viviano et al., 2020	SpyPoint Force-10, Browning Strike Force HD Pro, PenCam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~40-50
Warbington and Boyce 2020	Reconyx HyperFire	Infrared	N/A	N/A	N/A	No delay	3 pictures	N/A	N/A
Webber et al., 2020	Bushnell Trophy Cam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	900
Webster et al., 2021	Bushnell Trophy Cam HD Model 119537	LED flash	8 MP	N/A	N/A	30 sec	N/A	N/A	50-100
Weinstein et al., 2020	Moultrie Feeders model A-30	Passive infrared	N/A	0.7	N/A	N/A	3 pictures	N/A	50-100
Weise et al., 2014	Stealth Cam Rogue 5.0 model	Infrared	N/A	N/A	Set to ~5m	1 image every 4 seconds when triggered (1 min interval delay)	N/A	N/A	48
Welch and Parker 2016	Cuddeback Expert, Cuddeback Attack, Wildview Extreme 5	Passive Infrared	N/A	N/A	N/A	N/A	N/A	N/A	31-126

Welch et al., 2019	Wildview Xtreme 5	White flash	N/A	N/A	N/A	5 min	3 pictures burst	N/A	50-60
Wells et al., 2021	Browning Strike Force HD Pro X	N/A	N/A	N/A	N/A	60 sec	3 pictures	N/A	80
Wentzel et al., 2021	Cuddeback Attack IR Model 1158	Infrared	N/A	N/A	N/A	N/A	N/A	N/A	120-150
Wester 2019	Bushnell Nature View HD Max 119440	Infrared	N/A	0.7	N/A	1 sec	N/A	60 sec	N/A
White et al., 2017	Ltl Acorn 6210M	Infrared	N/A	N/A	N/A	No delay	1-3 pictures per trigger	60 sec	N/A
Whytock et al., 2021	Reconyx HP2X Hyperfire	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~30-40
Widdows et al., 2015	LtI Acorn 6210MC	Passive Infrared	N/A	N/A	N/A	60 sec	N/A	N/A	30-40
Widness and Aronsen 2018	DeerCam DC300, Cuddeback NF-4300, Recon Extreme Infrared Extreme Weather Model 5.0	Film (DeerCam), Infrared (Cuddeback)	N/A	N/A	~10	15 sec (analogue), 30-60 sec (digital)	N/A	15-45 sec (digital cameras)	50-100
Wilkinson et al., 2021	Bushnell TrophyCam E2	N/A	N/A	N/A	N/A	15 sec	2 pictures	N/A	N/A
Williams et al., 2014	Reconyx Rapidfire RC55	N/A	N/A	N/A	N/A	N/A	N/A	N/A	45
Williams et al., 2017	Reconyx Hyperfire HC500 and HC600	N/A	N/A	N/A	N/A	~1 sec	N/A	N/A	~40
Williams et al., 2018a	Cuddeback Ambush 1194 and 1170	Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	~30
Williams et al., 2018b	Cuddeback Ambush 1194 and 1170	Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	~30
Williams et al., 2021a	Panthera V-Series models V4, V5, V6, Cuddeback Attack	N/A	N/A	N/A	N/A	N/A	N/A	N/A	~40
Williams et al., 2021b	Panthera V-Series models V4, V5, V6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Winterbach et al., 2017	Panthera v4, Bushnell TrophyCam	Incandescent (Panthera v4), infrared (Bushnell)	N/A	N/A	N/A	30 sec, 15 sec at night for incandescent cameras	3 pictures	N/A	N/A
Winterton et al., 2020	Cuddeback C3 blackflash	N/A	N/A	N/A	N/A	30 sec	3 pictures burst	N/A	40-50
Wood et al., 2021	Bushnell Trophy Cam	Infrared	N/A	N/A	N/A	60 sec	N/A	N/A	~60
Woodgate et al., 2021	Bushnell Trophy Cam HD	N/A	N/A	N/A	N/A	30 sec	N/A	N/A	~30
Wreford et al., 2017	Bushnell Trophy Cam, Ltl Acorn 5210, Ltl Acorn 6210	N/A	N/A	N/A	N/A	10 sec	N/A	N/A	N/A
Zero et al., 2013	DeerCam	Film	N/A	N/A	N/A	30 sec	N/A	N/A	N/A
Zungu et al., 2019	LtI Acorn 6210MC, Moultrie M-880	Passive Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	15-25
Zungu et al., 2020a	LtI Acorn 6210MC, Moultrie M-880	Passive Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	15-25
Zungu et al., 2020b	LtI Acorn 6210MC, Moultrie M-880	Passive Infrared	N/A	N/A	N/A	30 sec	N/A	N/A	15-25

Supplementary Information S2.9. Summary of camera trap publications in Africa from 2005-2021 excluded in the review.

Full Reference
Abessolo Ondoa, G., Almar, R., Kestenare, E., Bahini, A., Houngue, G.H., Jouanno, J., Du Penhoat, Y., Castelle, B., Melet, A., Meyssignac, B., Anthony, E.J., Laibi, R., Alory, G., Ranasinghe, R., 2016. Potential of video cameras in assessing event and seasonal coastline behaviour: Grand Popo, Benin (Gulf of Guinea). Journal of Coastal Research, 442-446.
Ackaah, W., Aidoo, E.N., 2020. Modelling risk factors for red light violation in the Kumasi Metropolis, Ghana. International Journal of Injury Control and Safety Promotion 1-6.
Agha, M., Batter, T., Bolas, E.C., Collins, A. C., Gomes da Rocha, D., Monteza-Moreno, C. M., Preckler-Quisquater, S., Sollmann, R., 2018. A review of wildlife camera trapping trends across Africa. African Journal of Ecology 56, 694-701.
Agwanda, B.R., Rovero, F., Lawson, L.P., Vernesi, C., Amin, R., 2021. A new subspecies of giant sengi (Macroscelidea: Rhynchocyon) from coastal Kenya. Zootaxa 4948, zootaxa.4948.
Ahmed, S.A., Al-Sheikhly, O.F., 2021. First record of Blanford's Fox *Vulpes cana* (Blanford, 1877) from Iraq. Mammalia 85, 412-416.
Aihara, Y., Hosaka, T., Yasuda, M., Hashim, M., Numata, S., 2016. Mammalian wildlife tourism in South-east Asian tropical rainforests: the case of Endau Rompin National Park, Malaysia. Journal of Tropical Forest Science 28 167-181.
Ait Kaci Azzou, S., Singer, L., Aebischer, T., Caduff, M., Wolf, B., Wegmann, D., 2021. A sparse observation model to quantify species distributions and their overlap in space and time. Ecography 44, 928-940.
Aitkenhead, M.J., Poggio, L., Wardell-Johnson, D., Coull, M.C., Rivington, M., Black, H.I.J., Yacob, G., Boke, S., Habte, M., 2020. Estimating soil properties from smartphone imagery in Ethiopia. Computers and Electronics in Agriculture 171, 105322.
Alexander, J.S., Cusack, J.J., Pengju, C., Kun, S., Riordan, P., 2016. Conservation of snow leopards: spill-over benefits for other carnivores? Oryx 50, 239-243.
Allen, M.L., Ward, M.P., Južnič, D., Krofel, M., 2019. Scavenging by owls: a global review and new observations from Europe and North America. Journal of Raptor Research 53, 410-418.
Allen, M.L., Wang, S., Olson, L.O., Li, Q., Krofel, M., 2020. Counting cats for conservation: seasonal estimates of leopard density and drivers of distribution in the Serengeti. Biodiversity and Conservation 29, 3591-3608.
AlRashidi, M., Shobrak, M., 2015. Incubation routine of Saunders's Tern *Sternula saundersi* in a harsh environment. Avian Biology Research 8, 113-116.
Andreoni, K.J., Wagnon, C.J., Bestelmeyer, B.T., Schooley, R.L., 2021. Exotic oryx interact with shrub encroachment in the Chihuahuan Desert. Journal of Arid Environments 184, 104302.
Andrialovanirina, N., Ponton, D., Behivoke, F., Mahafina, J., Léopold, M., 2020. A powerful method for measuring fish size of small-scale fishery catches using ImageJ. Fisheries Research 223, 105425.
Antonio de la Torre, J., González-Maya, J.F., Zarza, H., Ceballos, G., Medellín, R.A., 2018. The jaguar's spots are darker than they appear: assessing the global conservation status of the jaguar *Panthera onca*. Oryx 52, 300-315.
Apps, P.J., McNutt, J.W., 2018. How camera traps work and how to work them. African Journal of Ecology 56, 702-709.
Aprile, A., Castellano, G., Eramo, G., 2014. Combining image analysis and modular neural networks for classification of mineral inclusions and pores in archaeological potsherds. Journal of Archaeological Science 50, 262-272.
Asgary, R., Staderini, N., Mthethwa-Hleta, S., Lopez Saavedra, P.A., Garcia Abrego, L., Rusch, B., Luce, T.M., Pasipamire, L.R., Ndlangamandla, M., Beideck, E., Kerschberger, B., 2020. Evaluating smartphone strategies for reliability, reproducibility, and quality of VIA for cervical cancer screening in the Shiselweni region of Eswatini: A cohort study. PLoS medicine 17, e1003378.
Ashraf, M.A., Li, C., Zhang, D., Zhao, L., Fakhri, A., 2021. Fabrication of silver phosphate-ilmenite nanocomposites supported on glycol chitosan for visible light-driven degradation, and antimicrobial activities. International Journal of Biological Macromolecules 169, 436-442.
Astaoui, G., Dadaiss, J.E., Sebari, I., Benmansour, S., Mohamed, E., 2021. Mapping wheat dry matter and nitrogen content dynamics and estimation of wheat yield using UAV multispectral imagery machine learning and a variety-based approach: case study of Morocco. AgriEngineering 3, 29-49.
Atkins, S., Cantor, M., Pillay, N., Cliff, G., Keith, M., Parra, G.J., 2016. Net loss of endangered humpback dolphins: integrating residency, site fidelity, and bycatch in shark nets. Marine Ecology Progress Series 555, 249-260.
Attum, O., Rosenbarger, D., Kramer, A., Eid, E., 2017. Population size and artificial waterhole use by striped hyenas in the Dana Biosphere Reserve, Jordan. Mammalia 81, 415-419.
Autry, A.M., Knight, S., Lester, F., Dubowitz, G., Byamugisha, J., Nsubuga, Y., Muyingo, M., Korn, A., 2013. Teaching surgical skills using video internet communication in a resource-limited setting. Obstetrics & Gynecology 122, 127-131.
Baena, S., Boyd, D.S., Moat, J., 2018. UAVs in pursuit of plant conservation-Real world experiences. Ecological Informatics 47, 2-9.
Bahaa-el-din, L., Cusack, J.J., 2018. Camera trapping in Africa: paving the way for ease of use and consistency. African Journal of Ecology 56, 690-693.
Bahaa-el-din, L., Henschel, P., Butynski, T.M., Macdonald, D.W., Mills, D., Slotow, R., Hunter, L., 2015. The African golden cat *Caracal aurata*: Africa's least-known felid. Mammal Review 45, 63-77.

Baissa, R., Labbassi, K., Launeau, P., Gaudin, A., Ouajhain, B., 2011. Using HySpex SWIR-320m hyperspectral data for the identification and mapping of minerals in hand specimens of carbonate rocks from the Ankloute Formation (Agadir Basin, Western Morocco). Journal of African Earth Sciences 61, 1-9.

Bajaba, S.Z., Hugo, S., van Wyk, A.J., Marr, S.M., Vine, N.G., & Weyl, O.L.F., 2021. Can bait improve the efficiency of underwater video monitoring of fish in headwater streams? A case study from the Rondegat River, South Africa. African Journal of Aquatic Science 46, 246-249.

Ballerio, A., 2021. The Ceratocanthinae of Madagascar and Comoro Islands: a revision of the genera Synarmostes and Goudotostes, and of the flightless Philharmostes, with description of 64 new species (Coleoptera: Scarabaeoidea: Hybosoridae). Fragmenta Entomologica 53, 105-282.

Bartel, S.L., Orrock, J.L., 2020. Past and present disturbances generate spatial variation in seed predation. Ecosphere 11, e03116.

Bastawrous, A., Giardini, M.E., Bolster, N.M., Peto, T., Shah, N., Iain A.T., Livingstone, I.A., Weiss, H.A., Hu, S., Rono, H., Kuper, H., Burton, M., 2016. Clinical validation of a smartphone-based adapter for optic disc imaging in Kenya. JAMA ophthalmology 134, 151-158.

Beaudrot, L., Acevedo, M., Lessard, J.P., Sheil, D., Larney, E., Wright, P., Ahumada, J., 2018. Distributional shifts in a biodiversity hotspot. Biological Conservation 228, 252-258.

Belant, J.L., Bled, F., Wilton, C.M., Fyumagwa, R., Mwampeta, S.B., Beyer Jr, D.E., 2016. Estimating lion abundance using N-mixture models for social species. Scientific Reports 6, 35920.

Bellan, S.E., Gimenez, O., Choquet, R., Getz, W.M., 2013. A hierarchical distance sampling approach to estimating mortality rates from opportunistic carcass surveillance data. Methods in Ecology and Evolution 4, 361-369.

Bellina, L., Missoni, E., 2009. Mobile cell-phones (M-phones) in telemicroscopy: increasing connectivity of isolated laboratories. Diagnostic pathology 4, 19.

Belloch, J.A., Badia, J.M., Igual, F.D., Cobos, M., Quintana-Ortí, E.S., 2017. On the use of a GPU-accelerated mobile device processor for sound source localization. Procedia Computer Science 108, 586-595.

Ben Bahri, O., Lazreg, N., Besbes, K., 2019. Smartphone-Based Telemedicine Supported by Pico-Satellite Constellation. IETE Journal of Research 65, 726-735.

Bhandari, S., Bhusal, D.R., Psaralexi, M., Sgardelis, S., 2021. Habitat preference indicators for striped hyena (*Hyaena hyaena*) in Nepal. Global Ecology and Conservation 27, e01619.

Bishop, J.L., Tirsch, D., Tornabene, L.L., Jaumann, R., McEwen, A.S., McGuire, P.C., Ody, A., Poulet, F., Clark, P.N., Parente, M., McKeown, N. K., Mustard, J.F., Murchie, S.L., Voigt, J., Aydin, Z., Bamberg, M., Petau, A., Michael, G., Seelos, F.P., Hash, C.D., Swayze, G.A., Neukum, G., 2013. Mineralogy and morphology of geologic units at Libya Montes, Mars: Ancient aqueously derived outcrops, mafic flows, fluvial features, and impacts. Journal of Geophysical Research: Planets 118, 487-513.

Bondi, E., Fang, F., Hamilton, M., Kar, D., Dmello, D., Choi, J., Hannaford, R., Lyer, A., Joppa, L., Tambe, M., Nevatia, R., 2018. Spot poachers in action: Augmenting conservation drones with automatic detection in near real time. In Thirty-Second AAAI Conference on Artificial Intelligence (pp. 7741-7746).

Boon, M.A., Greenfield, R., Tesfamichael, S., 2016. Wetland assessment using unmanned aerial vehicle (UAV) photogrammetry. In 23rd Congress of the International-Society-for-Photogrammetry-and-Remote-Sensing (ISPRS) (Vol. 41, pp 781-788).

Boon, M.A., Greenfield, R., Tesfamichael, S., 2016. Unmanned aerial vehicle (UAV) photogrammetry produces accurate high-resolution orthophotos, point clouds and surface models for mapping wetlands. South African Journal of Geomatics 5, 186-200.

Boone, A., Kraft, J.P., Stapp, P., 2009. Scavenging by mammalian carnivores on prairie dog colonies: implications for the spread of plague. Vector-Borne and Zoonotic Diseases 9, 185-190.

Boone IV, W.W., McCleery, R.A., Reichert, B.E., 2017. Fox squirrel response to forest restoration treatments in longleaf pine. Journal of Mammalogy 98, 1594-1603.

Bosch, N.E., Gonçalves, J.M., Tuya, F., Erzini, K., 2017. Marinas as habitats for nearshore fish assemblages: comparative analysis of underwater visual census, baited cameras and fish traps. Scientia Marina 81, 159-169.

Botelho, A.L.M., Borges, L.H.M., McFarland, B., 2018. Abundance and composition of the medium to large-sized mammals in a private area of a REDD+ project in Acre, Brazil. Biota Neotropica 18, e20170487.

Braczkowski, A., Gopalaswamy, A.M., Elliot, N.B., Possingham, H.P., Bezzina, A., Maron, M., Biggs, D., Allan, J.R., 2020. Restoring Africa's lions: start with good counts. Frontiers in Ecology and Evolution 8, 138.

Branco, P.S., Merkle, J.A., Pringle, R.M., King, L., Tindall, T., Stalmans, M., Long, R.A., 2020. An experimental test of community-based strategies for mitigating human–wildlife conflict around protected areas. Conservation Letters 13, e12679.

Brivio, P.A., Petrucci, B., Boschetti, M., Carrara, P., Pepe, M., Rampini, A., Stroppiana, D., Zaffaroni, P., 2009. A multi-year geographic database of fire affected areas derived from satellite images in the National Parks of Italy. Italian Journal of Remote Sensing 41, 65-78.

Brodie, J.F., Pangau-Adam, M., 2017. Human impacts on two endemic cassowary species in Indonesian New Guinea. Oryx 51, 354-360.

Brodie, J.F., Giordano, A. J., Dickson, B., Hebblewhite, M., Bernard, H., Mohd-Azlan, J., Anderson, J., Ambu, L., 2015. Evaluating multispecies landscape connectivity in a threatened tropical mammal community. Conservation Biology 29, 122-132.

Brust, C.A., Burghardt, T., Groenenberg, M., Kading, C., Kuhl, H.S., Manguette, M.L., Denzler, J., 2017. Towards automated visual monitoring of individual gorillas in the wild. In Proceedings of the IEEE International Conference on Computer Vision Workshops (pp 2820-2830).

Buerkert, A., Mahler, F., Marschner, H., 1996. Soil productivity management and plant growth in the Sahel: potential of an aerial monitoring technique. Plant and Soil 180, 29-38.

Burton, A.C., 2012. Critical evaluation of a long-term, locally-based wildlife monitoring program in West Africa. Biodiversity and Conservation 21, 3079-3094.

Bush, E.R., Mitchard, E.T., Silva, T.S., Dimoto, E., Dimbonda, P., Makaga, L., Abernethy, K., 2020. Monitoring Mega-Crown Leaf Turnover from Space. Remote Sensing 12, 429.

Calvari, S., Ganci, G., Victória, S. S., Hernandez, P. A., Perez, N. M., Barrancos, J., Alfama, V., Dionis, S., Cabral, J., Cardoso, N., Fernandes, P., Melian, G., Pereira, J.M., Semedo, H., Padilla, G., Rodriguez, F., 2018. Satellite and Ground Remote Sensing Techniques to Trace the Hidden Growth of a Lava Flow Field: The 2014–2015 Effusive Eruption at Fogo Volcano (Cape Verde). Remote Sensing 10, 1115.

Castañeda, R.A., Van Nynatten, A., Crookes, S., Ellender, B.R., Heath, D.D., MacIsaac, H.J., Mandrak, N.E., Weyl, O.L.F., 2020. Detecting native freshwater fishes using novel non-invasive methods. Frontiers in Environmental Science 8, 1-16.

Caumes, E., Le Bris, V., Couzigou, C., Menard, A., Janier, M., Flahault, A., 2004. Dermatoses associated with travel to Burkina Faso and diagnosed by means of teledermatology. British Journal of Dermatology 150, 312-316.

Chang, A.Y., Ghose, S., Littman-Quinn, R., Anolik, R.B., Kyer, A., Mazhani, L., Seymour, A.K., Kovarik, C.L., 2012. Use of mobile learning by resident physicians in Botswana. Telemedicine and e-Health 18, 11-13.

Chatterjee, N., Nigam, P., Habib, B., 2020. Population estimate, habitat-use and activity patterns of the honey badger in a dry-deciduous forest of central India. Frontiers in Ecology and Evolution 585256, 8.

Chazanga, F.C., Phiri, J., Namukolo, S., 2019. Development of a Two Factor Authentication for Vehicle Parking Space Control based on Automatic Number Plate Recognition and Radio Frequency Identification. Development 10, 1-4.

Cheyne, S.M., Sastramidjaja, W.J., Rayadin, Y., Macdonald, D.W., 2016. Mammalian communities as indicators of disturbance across Indonesian Borneo. Global Ecology and Conservation 7, 157-173.

Cheyne, S.M., Neale, C.J., Thompson, C., Wilcox, C.H., Ehlers Smith, Y.C., Ehlers Smith, D.A., 2018. Down from the treetops: red langur (*Presbytis rubicunda*) terrestrial behavior. Primates 59, 437-448.

Chirico, P.G., DeWitt, J.D., 2017. Mapping informal small-scale mining features in a data-sparse tropical environment with a small UAS. Journal of Unmanned Vehicle Systems 5, 69-91.

Chun, F.K., Tippets, R.D., Strong, D.M., Della-Rose, D.J., Polsgrove, D.E., Gresham, K.C., Reid, J.A., Christy, C.P., Korbitz, M., Gray, J., Gartin, S., Coles, D., Haaland, R.K., Walker, R., Workman, J., Mansur, J., Hancock, T., Erdley, J.D., Taylor, T.S., Peters, R.A., Palma, C.X., Mandeville, W., Bygren, S., Randall, C., Schafer, K., McLaughlin, T., Castellón, J.L.N., Rivera, A.C.R., Larenas, H.A.C., Lambert, A., Polo, M.C., Blair, D., Gargano, M., Devlin, J., Tonello, R., Wiedemann, C., Kebschull, C., Stoll, E., 2018. A new global array of optical telescopes: The falcon telescope network. Publications of the Astronomical Society of the Pacific 130, 095003.

Cigna, F., Tapete, D., Lu, Z., 2020. Remote sensing of volcanic processes and risk. Remote Sensing 12, 2567.

Cohen, D.Y., Parrish, A.G., Sadiq, S.T., 2013. Improving clinical governance of HIV treatment programmes in resource poor settings: the role of digitising clinical notes. International Journal of STD & AIDS 24, 829-830.

Corr, P., Couper, I., Beningfield, S.J., Mars, M., 2000. A simple telemedicine system using a digital camera. Journal of Telemedicine and Telecare 6, 233-236.

Cucho-Padin, G., Loayza, H., Palacios, S., Balcazar, M., Carbajal, M., Quiroz, R., 2019. Development of low-cost remote sensing tools and methods for supporting smallholder agriculture. Applied Geomatics, 1-17.

Cusack, J., Bahaa-el-din, L., 2018. African Journal of Ecology special section-Camera trapping in Africa. African Journal of Ecology 56, 689-689.

Das, D.K., 2021. Revitalising South African city centres through ICT. Urban Planning 6, 228-241.

Dasari, A., Prakash, S.K.A., Jeni, L.A., Tucker, C.S., 2021. Evaluation of biases in remote photoplethysmography methods. NPJ Digital Medicine 4, 91.

de Barros Santos, E., Moher, P., Ferlin, S., Fostier, A.H., Mazali, I.O., Telmer, K., Brolo, A.G., 2017. Proof of concept for a passive sampler for monitoring of gaseous elemental mercury in artisanal gold mining. Scientific Reports 7, 16513.

Dematteis, N., Giordan, D., 2021. Comparison of digital image correlation methods and the impact of noise in geoscience applications. Remote Sensing 13, 327.

Dione, C., Lohou, F., Lothon, M., Adler, B., Babić, K., Kalthoff, N., Pedruzo-Bagazgoitia, X., Bezombes, Y., Gabella, O., 2019. Low-level stratiform clouds and dynamical features observed within the southern West African monsoon. Atmospheric Chemistry and Physics 19, 8979-8997.

Dobson, A., Nowak, K., 2010. Does this photo make my range look big? Animal Conservation 13, 347-349.

D'Oleire-Oltmanns, S., Marzolff, I., Peter, K.D., Ries, J.B., 2012. Unmanned aerial vehicle (UAV) for monitoring soil erosion in Morocco. Remote Sensing 4, 3390-3416.

Eames, T., Russell-Smith, J., Yates, C., Edwards, A., Vernooij, R., Ribeiro, N., Steinbruch, F., van der Werf, G.R., 2021. Instantaneous pre-fire biomass and fuel load measurements from multi-spectral UAS mapping in southern African Savannas. Fire 4, 1-19.

Egna, N., O'Connor, D., Stacy-Dawes, J., Tobler, M.W., Pilfold, N., Neilson, K., Simmons, B., Davis, E.O., Bowler, M., Fennessy, J., Glikman, J.A., Larpei, L., Lekalgitele, J., Lekupanai, R., Lekushan, J., Lemingani, L., Lemirgishan, J., Lenaipa, D., Lenyakopiro, J., Lesipiti, R.L., Lororua, M., Muneza, A., Rabhayo, S., Ranah, S.M.O., Ruppert, K., Owen, M., 2020. Camera settings and biome influence the accuracy of citizen science approaches to camera trap image classification. Ecology and Evolution 10, 11954-11965.

Eva, H., Lambin, E.F., 1998. Remote sensing of biomass burning in tropical regions: Sampling issues and multisensor approach. Remote Sensing of Environment 64, 292-315.

Fahmy, M., Williams, K.M., Tessler, M., Weiskopf, S.R., Hekkala, E., Siddall, M.E., 2020. Multilocus metabarcoding of terrestrial leech bloodmeal iDNA increases species richness uncovered in surveys of vertebrate host biodiversity. The Journal of Parasitology 106, 843-853.

Fidino, M., Gallo, T., Lehrer, E.W., Murray, M.H., Kay, C.A.M., Sander, H.A., MacDougall, B., Salsbury, C.M., Ryan, T.J., Angstmann, J.L., Belaire, A., Dugelby, B., Schell, C.J., Stankowich, T., Amaya, M., Drake, D., Hursh, S.H., Ahlers, A.A., Williamson, J., Hartley, L.M., Zellmer, A.J., Simon, K., Magle, S.B., 2021. Landscape-scale differences among cities alter common species' responses to urbanization. Ecological Applications 31, e02253.

Fletcher, R.J., McCleery, R.A., Greene, D.U., Tye, C.A., 2016. Integrated models that unite local and regional data reveal larger-scale environmental relationships and improve predictions of species distributions. Landscape Ecology 31, 1369-1382.

Francis, R.J., Lyons, M.B., Kingsford, R.T., Brandis, K.J., 2020. Counting Mixed Breeding Aggregations of Animal Species Using Drones: Lessons from Waterbirds on Semi-Automation. Remote Sensing 12, 1185.

Frias-Torres, S., 2017. Captive Bred, Adult Giant Clams Survive Restoration in the Wild in Seychelles, Indian Ocean. Frontiers in Marine Science 4, 97.

Frias-Torres, S., van de Geer, C., 2015. Testing animal-assisted cleaning prior to transplantation in coral reef restoration. PeerJ 3, e1287.

Gillibrand, E.J.V., Bagley, P., Jamieson, A., Herring, P.J., Partridge, J.C., Collins, M.A., Milne, R., Priede, I.G., 2007. Deep sea benthic bioluminescence at artificial food falls, 1,000–4,800 m depth, in the Porcupine Seabight and Abyssal Plain, North East Atlantic Ocean. Marine Biology 150, 1053-1060.

Glaudas, X., Alexander, G.J., 2017. Food supplementation affects the foraging ecology of a low-energy, ambush-foraging snake. Behavioral Ecology and Sociobiology 71, 5.

Gorczynski, D., Hsieh, C., Luciano, J.T., Ahumada, J., Espinosa, S., Johnson, S., Rovero, F., Santos, F., Andrianarisoa, M.H., Astaiza, J.H., Jansen, P.A., Kayijamahe, C., Lima, M.G.M., Salvador, J., Beaudrot, L., 2021. Tropical mammal functional diversity increases with productivity but decreases with anthropogenic disturbance. Proceedings of the Royal Society B 288, 20202098.

Gracia-Romero, A., Kefauver, S.C., Vergara-Díaz, O., Zaman-Allah, M.A., Prasanna, B.M., Cairns, J.E., Araus, J.L., 2017. Comparative performance of ground vs. aerially assessed RGB and multispectral indices for early-growth evaluation of maize performance under phosphorus fertilization. Frontiers in Plant Science 8, 2004.

Gracia-Romero, A., Kefauver, S.C., Vergara-Díaz, O., Hamadziripi, E., Zaman-Allah, M.A., Thierfelder, C., Prassana, B.M., Cairns, J.E., Araus, J.L., 2020. Leaf versus whole-canopy remote sensing methodologies for crop monitoring under conservation agriculture: a case of study with maize in Zimbabwe. Scientific Reports 10, 1-17.

Graham, E., Vaughan, R., Buckley, D., Tirima, K., 2015. Search for an Astronomical Site in Kenya (SASKYA) update: Installation of on-site automatic meteorological stations. In Journal of Physics: Conference Series (Vol. 595, 012012).

Greene, D.U., McCleery, R.A., 2017. Multi-scale responses of fox squirrels to land-use changes in Florida: Utilization mimics historic pine savannas. Forest Ecology and Management 391, 42-51.

Greene, D.U., McCleery, R.A., 2017. Reevaluating fox squirrel (*Sciurus niger*) population declines in the southeastern United States. Journal of Mammalogy 98, 502-512.

Greene, D.U., McCleery, R.A., Wagner, L.M., Garrison, E.P., 2016. A comparison of four survey methods for detecting fox squirrels in the southeastern United States. Journal of Fish and Wildlife Management 7, 99-106.

Gurba, A., Harraca, V., Perret, J.L., Casera, S., Donnet, S., Guerin, P.M., 2012. Three-dimensional flight tracking shows how a visual target alters tsetse fly responses to human breath in a wind tunnel. Physiological Entomology 37, 250-257.

Hall, O., Dahlin, S., Marstorp, H., Archila Bustos, M.F., Öborn, I., Jirström, M., 2018. Classification of maize in complex smallholder farming systems using UAV imagery. Drones 2, 1-8.

Harris, G., Sanderson, J.G., Erz, J., Lehnen, S.E., Butler, M.J., 2015. Weather and prey predict mammals' visitation to water. PLoS ONE 10, e0141355.

Hepler, S.A., Erhardt, R.J., 2021. A spatiotemporal model for multivariate occupancy data. Environmetrics 32, e2657.

Hepler, S.A., Erhardt, R., Anderson, T.M., 2018. Identifying drivers of spatial variation in occupancy with limited replication camera trap data. Ecology 99, 2152-2158.

Humber, F., Godley, B.J., Ramahery, V., Broderick, A.C., 2011. Using community members to assess artisanal fisheries: the marine turtle fishery in Madagascar. Animal Conservation 14, 175-185.

Ingold, K., Kapenuka, T., 2016. Creatively connecting global classrooms: strategies to overcome technological challenges. In 10th International Technology, Education and Development Conference (pp 8413-8417).

Ingram, D.J., Willcox, D., Challender, D.W., 2019. Evaluation of the application of methods used to detect and monitor selected mammalian taxa to pangolin monitoring. Global Ecology and Conservation 18, e00632.

Inoue, E., Akomo-Okoue, E.F., 2015. Application of DNA barcoding techniques to mammal inventories in the African rain forest: droppings may inform us of the owners. Tropics 23, 137-150.

Ismaila, N., Maloueki, U., 2021. Gorilla Abundance Estimations within North-East Moukalaba-Doudou National Park, Gabon. Folia Primatologica 92, 103-111.

Jagoe, K., Rossanese, M., Charron, D., Rouse, J., Waweru, F., Waruguru, M., Delapena, S., Piedrahita, R., Livingston, K., Ipe, J., 2020. Sharing the burden: Shifts in family time use, agency and gender dynamics after introduction of new cookstoves in rural Kenya. Energy Research & Social Science 64, 101413.

Jankowsky, F., Wagner, S., 2014. Full automation of the automatic telescope for optical monitoring. In Observatory Operations: Strategies, Processes, and Systems V (Vol. 9149, 91491Y).

Jiang, W., Kumar, V., Mehta, N., Bott, J., Modi, V., 2020. Irrigation detection by car: Computer vision and sensing for the detection and geolocation of irrigated and non-irrigated farmland. In 2020 IEEE Global Humanitarian Technology Conference (GHTC) (pp 1-4).

Johnson, S.D., Raguso, R.A., 2016. The long-tongued hawkmoth pollinator niche for native and invasive plants in Africa. Annals of Botany 117, 25-36.

Jordaan, R.K., Somers, M.J., McIntyre, T., 2017. Dancing to the message: African clawless otter scent marking behaviour. Hystrix-Italian Journal of Mammalogy 28, 277-279.

Joubert, C.J., Tarugara, A., Clegg, B.W., Gandiwa, E., Muposhi, V.K., 2020. A baited-camera trapping method for estimating the size and sex structure of African leopard (*Panthera pardus*) populations. MethodsX 7, 101042.

Kagi, H., Sato, S., Akagi, T., Kanda, H., 2007. Generation history of carbonado inferred from photoluminescence spectra, cathodoluminescence imaging, and carbon-isotopic composition. American Mineralogist 92, 217-224.

Kalan, A. K., Hohmann, G., Arandjelovic, M., Boesch, C., McCarthy, M.S., Agbor, A., Angedakin, S., Bailey, E., Balongelwa, C.W., Bessone, M., Bocksberger, G., Coxe, S.J., Deschner, T., Després-Einspenner, M., Dieguez, P., Fruth, B., Herbinger, I., Granjon, A., Head, J., Kablan, Y.A., Langergraber, K.E., Lokasola, A.L., Maretti, G., Marrocoli, S., Mbende, M., Moustgaard, J., N’Goran, K., Robbins, M.M., van Schijndel, J., Sommer, V., Surbeck, M., Tagg, N., Willie, J., Wittig, R.M., Kühl, H.S., 2019. Novelty response of wild African apes to camera traps. Current Biology 29, 1211-1217.

Kaluza, J., Donald, R.L., Gynther, I.C., Leung, L.K., Allen, B.L., 2016. The distribution and density of water mice (*Xeromys myoides*) in the Maroochy River of Southeast Queensland, Australia. PLoS ONE 11, e0146133.

Karpanty, S.M., Crawford, C., Gerber, B., Kotshwar, M., 2008. Using camera-traps and traditional knowledge to estimate population parameters and movements of carnivores in southeastern Madagascar: tools towards better understanding lemur predation risk from a predator's perspective. In 77th Annual Meeting of the American-Association-of-Physical-Anthropologists (pp 128-128).

Keen, E.M., Wray, J., Hendricks, B., O’Mahony, É., Picard, C.R., Alidina, H., 2020. Determining marine mammal detection functions for a stationary land-based survey site. Wildlife Research 48, 115-126.

Keeping, D., 2014. Rapid assessment of wildlife abundance: estimating animal density with track counts using body mass–day range scaling rules. Animal Conservation 17, 486-497.

Keeping, D., Burger, J.H., Keitsile, A.O., Gielen, M.C., Mudongo, E., Wallgren, M., Skarpe, C., Foote, A.L., 2018. Can trackers count free-ranging wildlife as effectively and efficiently as conventional aerial survey and distance sampling? Implications for citizen science in the Kalahari, Botswana. Biological Conservation 223, 156-169.

Kefauver, S.C., El-Haddad, G., Vergara-Diaz, O., Araus, J.L., 2015. RGB Picture vegetation indexes for high-throughput phenotyping platforms (HTPPs). In Remote Sensing for Agriculture, Ecosystems, and Hydrology XVII (Vol. 9637, 96370J).

Kelly, C., 1998. Bridging the gap: remote sensing and needs assessment—a field experience with displaced populations. Safety Science 30, 123-129.

Kennedy, B., Brown, W.Y., Vernes, K., Körtner, G., Butler, J.R., 2018. Dog and cat interactions in a remote Aboriginal community. Animals 8, 65.

Khwaja, H., Buchan, C., Wearn, O.R., Bahaa-eldin, L., Bantlin, D., Bernard, H., Bitariho, R., Bohm, T., Borah, J., Brodie, J., Chutipong, W., du Preez, B., Ebang-Mbele, A., Edwards, S., Fairet, E., Frechette, J.L., Garside, A., Gibson, L., Giordano, A., Gopi, G.V., Granados, A., Gubbi, S., Harich, F., Haurez, B., Havmøller, R.W., Helmy, O., Isbell, L.A., Jenks, K., Kalle, R., Kamjing, A., Khamcha, D., Kiebou-Opepa, C., Kinnaird, M., Kruger, C., Laudisoit, A., Lynam, A., Macdonald, S.E., Mathai, J., Metsio Sienne, J., Meier, A., Mills, D., Mohd-Azlam, J., Nakashima, Y., Nash, H.C., Ngoprasert, D., Nguyen. A., O’Brien, T., Olson, D., Orbell, C., Poulsen, J., Ramesh, T., Reeder, D., Reyna, R., Rich, L.N., Rode-Margono, J., Rovero, F., Sheil, D., Shirley, M.H., Stratford, K., Sukumal, N., Suwanrat, S., Tantipisanuh, N., Tilker, A., Van Berkel, T., Van der Weyde, L.K., Varney, M., Weise, F., Wiesel, I., Wilting, A., Wong, S.T., Waterman, C., Challender, D.W.S., 2019. Pangolins in global camera trap data: Implications for ecological monitoring. Global Ecology and Conservation 20, e00769.

King, M.D., Platnick, S., Moeller, C.C., Revercomb, H.E., Chu, D.A., 2003. Remote sensing of smoke, land, and clouds from the NASA ER-2 during SAFARI 2000. Journal of Geophysical Research: Atmospheres 108, 8502.

Klailova, M., Casanova, C., Henschel, P., Lee, P., Rovero, F., Todd, A., 2012. Non-human predator interactions with wild great apes in Africa and the use of camera traps to study their dynamics. Folia Primatologica 83, 312-328.

Kobayashi, S., Panha, S., Seesamut, T., Nantarat, N., Likhitrakarn, N., Denda, T., Izawa, M., 2021. First record of non-flying mammalian contributors to pollination in a tropical montane forest in Asia. Ecology and Evolution 11, 17604-17608.

Koeva, M., Gasuku, O., Lengoiboni, M., Asiama, K., Bennett, R.M., Potel, J., Zevenbergen, J., 2021. Remote sensing for property valuation: A data source comparison in support of fair land taxation in Rwanda. Remote Sensing 13, 3563.

Korchia, C.S.F., Noonburg, E.G., Ayali, P., Hart, T.B., Hart, J.A., Detwiler, K.M., 2019. Applying the random encounter model to estimate density of Cercopithecus lomamiensis from camera traps in the Lomami National Park and buffer zone of the Democratic Republic of the Congo. In 88th Annual Meeting of the American-Association-of-Physical-Anthropologists (AAPA) (Vol. 168, pp 76-76).

Laurin, G.V., Ding, J., Disney, M., Bartholomeus, H., Herold, M., Papale, D., Valentini, R., 2019. Tree height in tropical forest as measured by different ground, proximal, and remote sensing instruments, and impacts on above ground biomass estimates. International Journal of Applied Earth Observation and Geoinformation 82, 101899.

Linder, E., Grote, A., Varjo, S., Linder, N., Lebbad, M., Lundin, M., Diwan, V., Hannuksela, J., Lundin, J., 2013. On-chip imaging of *Schistosoma haematobium* eggs in urine for diagnosis by computer vision. PLoS Neglected Tropical Diseases 7, e2547.

Linkie, M., Martyr, D.J., Holden, J., Yanuar, A., Hartana, A.T., Sugardjito, J., Leader-Williams, N., 2003. Habitat destruction and poaching threaten the Sumatran tiger in Kerinci Seblat National Park, Sumatra. Oryx 37, 41-48.

Liu, E.J., Aiuppa, A., Alan, A., Arellano, S., Bitetto, M., Bobrowski, N., Carn, S., Clarke, R., Corrales, E., de Moor, J.M., Diaz, J.A., Edmonds, M., Fischer, T.P., Freer, J., Fricke, G.M., Galle, B., Gerdes, G., Giudice, G., Gutmann, A., Hayer, C., Itikarai, I., Jones, J., Mason, E., McCormick Kilbride, B.T., Mulina, K., Nowicki, S., Rahilly, K., Richardson, T., Rüdiger, J., Schipper, C.I., Watson, I.M., Wood, K., 2020. Aerial strategies advance volcanic gas measurements at inaccessible, strongly degassing volcanoes. Science Advances 6, eabb9103.

Livingston, W., 2019. Geostationary Satellite over East Africa Observed from Kitt Peak, Arizona. Bulletin of the American Meteorological Society 100, 1877-1880.

Lombardi, G.C., Midgley, J.J., Turner, R.C., Peter, C.I., 2021. Pollination biology of *Erica aristata*: First confirmation of long-proboscid fly-pollination in the Ericaceae. South African Journal of Botany 142, 403-408.

Luis, P.G.J., Tomás, M.C.A., Vicente, B.C., Alejandro, J.S., 2019. Photogrammetric studies of inaccessible sites in archaeology: case study of burial chambers in Qubbet el-Hawa (Aswan, Egypt). Journal of Archaeological Science 102, 1-10.

Luisa Buchaillot, M., Gracia-Romero, A., Vergara-Diaz, O., Zaman-Allah, M.A., Tarekegne, A., Cairns, J. E., Prasanna, B.M., Araus, J.L., Kefauver, S.C., 2019. Evaluating maize genotype performance under low nitrogen conditions using RGB UAV phenotyping techniques. Sensors 19, 1815.

Maaoui, M.A.E., Chehata, N., Chahed, T.S., 2020. Assessment of airborne photogrammetric Dsm accuracy for forest canopy modelling: Application In Tunisia. In 2020 Mediterranean and Middle-East Geoscience and Remote Sensing Symposium (M2GARSS) (pp 363-366).

Madikizela, L.M., Chimuka, L., 2017. Simultaneous determination of naproxen, ibuprofen and diclofenac in wastewater using solid-phase extraction with high performance liquid chromatography. Water SA 43, 264-274.

Maeno, K.O., Piou, C., Kearney, M.R., Ould Ely, S., Ould Mohamed, S.A., Jaavar, M.E.H., Ould Babah Ebbe, M.A., 2021. A general model of the thermal constraints on the world's most destructive locust, *Schistocerca gregaria*. Ecological Applications 31, e02310.

Mahmoud, W.M., Kümmerer, K., 2012. Captopril and its dimer captopril disulfide: Photodegradation, aerobic biodegradation and identification of transformation products by HPLC–UV and LC–ion trap-MSn. Chemosphere 88, 1170-1177.

Maia, M., Clausen, P.H., Mehlitz, D., Garms, R., Bauer, B., 2010. Protection of confined cattle against biting and nuisance flies (Muscidae: Diptera) with insecticide-treated nets in the Ghanaian forest zone at Kumasi. Parasitology Research 106, 1307-1313.

Maltese, D., Reichert, O., 2015. Maritime piracy: design of an infrared multiple cameras system for short-range detection and targeting. In 41st Conference on Infrared Technology and Applications XLI (Vol. 9451, 94510A).

Maltsev, A.V., Parsons, S.P., Kim, M.S., Tsutsui, K., Stern, M.D., Lakatta, E.G., Maltsev, V.A., Monfredi, O., 2017. Computer algorithms for automated detection and analysis of local Ca2+ releases in spontaneously beating cardiac pacemaker cells. PloS ONE 12, e0179419.

Mananze, S., Pôças, I., Cunha, M., 2019. Agricultural drought monitoring based on soil moisture derived from the optical trapezoid model in Mozambique. Journal of Applied Remote Sensing 13, 024519.

Marks, B.K., Duncan, R.S., 2009. Use of forest edges by free-ranging cats and dogs in an urban forest fragment. Southeastern Naturalist 8, 427-436.

Martínez-Íñigo, L., Baas, P., Klein, H., Pika, S., Deschner, T., 2021. Home range size in central chimpanzees (*Pan troglodytes troglodytes*) from Loango National Park, Gabon. Primates 62, 723-734.

Matimba, A., Woodward, R., Tambo, E., Ramsay, M., Gwanzura, L., Guramatunhu, S., 2016. Tele-ophthalmology: Opportunities for improving diabetes eye care in resource-and specialist-limited Sub-Saharan African countries. Journal of Telemedicine and Telecare 22, 311-316.

Mattéo, L., Manighetti, I., Tarabalka, Y., Gaucel, J.M., van Den Ende, M., Mercier, A., Tasar, O., Girard, N., Leclerc, F., Giampetro, T., Dominguez, S., Malavieille, J., 2021. Automatic fault mapping in remote optical images and topographic data with deep learning. Journal of Geophysical Research: Solid Earth 126, e2020JB021269.

McCallum, J.W., Rowcliffe, J.M., Cuthill, I.C., 2014. Conservation on international boundaries: the impact of security barriers on selected terrestrial mammals in four protected areas in Arizona, USA. PLoS ONE 9, e93679.

McCarthy, C., Rees, S., Baillie, C., 2013. Preliminary evaluation of shape and colour image sensing for automated weed identification in sugarcane. International Sugar Journal 115, 560-564.

McDonald, C., McGloin, D., 2015. Low-cost optical manipulation using hanging droplets of PDMS. RSC Advances 5, 55561-55565.

McIntyre, J.K., Wolf, L.L., Sacks, B.N., Koibur, J., Brisbin, I.L., 2019. A population of free-living highland wild dogs in Indonesian Papua. Australian Mammalogy 42, 160-166.

McKaye, K.R., Mughogho, D.E., Lovullo, T.J., 1992. Formation of the selfish school. Environmental Biology of Fishes 35, 213-218.

McKaye, K.R., Mughogho, D.E., Stauffer Jr, J.R., 1994. Sex-role differentiation in feeding and defence of young by a biparental catfish, *Bagrus meridionalis*. Animal Behaviour 48, 587-596.

McKellar, A.E., Shephard, N.G., Chabot, D., 2021. Dual visible-thermal camera approach facilitates drone surveys of colonial marshbirds. Remote Sensing in Ecology and Conservation 7, 214-226.

McPhee, S.G., Ayali, P., Hart, J.A., Detwiler, K.M., 2014. Using video camera traps to study the behavior of the newly announced Guenon lesula, Cercopithecus lomamiensis, from the Lomami River basin, Democratic Republic of the Congo. In 37th Annual Meeting of the American-Society-of-Primatologists (Vol. 76, pp 84-84).

Meinich-Bache, Ø., Engan, K., Austvoll, I., Eftestøl, T., Myklebust, H., Yarrot, L.B., Kidanto, H., Ersdal, H., 2019. Object detection during newborn resuscitation activities. IEEE Journal of Biomedical and Health Informatics 24, 796-803.

Mena, J.L., Pacheco, V., 2020. Mountains and traits: environmental heterogeneity and mammal assemblages along an elevational gradient in the Northern Andes. Studies on Neotropical Fauna and Environment, 1-13.

Midlane, N., O'Riain, M.J., Balme, G.A., Hunter, L.T., 2015. To track or to call: comparing methods for estimating population abundance of African lions *Panthera leo* in Kafue National Park. Biodiversity and Conservation 24, 1311-1327.

Mohammed, F., Fritz, H.M., 2010. Experiments on tsunamis generated by 3D granular landslides. In 4th International Symposium on Submarine Mass Movements and Their Consequences (Vol. 28, pp 705-718).

Moore, J.F., Uzabaho, E., Musana, A., Uwingeli, P., Hines, J.E., Nichols, J.D., 2021. What is the effect of poaching activity on wildlife species? Ecological Applications 31, e02397.

Moulane, Y., Benkhaldoun, Z., Jehin, E., Opitom, C., Gillon, M., Daassou, A., 2017. Monitoring of comets activity and composition with the TRAPPIST-North telescope. In International Conference Frontiers in Theoretical and Applied Physics (FTAPS) (Vol. 869, 012079).

Muvengwi, J., Ndagurwa, H.G., 2015. Soil seed bank dynamics and fertility on a seasonal wetland invaded by *Lantana camara* in a savanna ecosystem. South African Journal of Botany 100, 190-194.

NaitAmor, S., AlAbdoadaim, M. A., Cohen, M.B., Cotts, B.R.T., Soula, S., Chanrion, O., Neubert, T., Abdelatif, T., 2010. VLF observations of ionospheric disturbances in association with TLEs from the EuroSprite-2007 campaign. Journal of Geophysical Research: Space Physics 115, A00E47.

Narvaez-Torres, P.R., Chen, D., Tiafinjaka, O., Louis Jr, E.E., Johnson, S.E., 2020. Using camera traps to study the impacts of disturbance on the abundance of two lemur species in southeast Madagascar. In 89th Annual Meeting of the American-Association-of-Physical-Anthropologists (AAPA) (Vol. 171, pp 196-196).

Naufal, F., Brady, C.J., Wolle, M.A., Saheb Kashaf, M., Mkocha, H., Bradley, C., Kabona, G., Ngondi, J., Massof, R.W., West, S.K., 2021. Evaluation of photography using head-mounted display technology (ICAPS) for district Trachoma surveys. PLoS Neglected Tropical Diseases 15, e0009928.

Neubert, T., Allin, T.H., Blanc, E., Farges, T., Haldoupis, C., Mika, A., Soula, S., Knutsson, L., van der Velde, O., Marshall, R.A., Inan, U., Sátori, G., Bór, J., Hughes, A., Collier, A., Laursen, S., Rasmussen, I.L., 2005. Co-ordinated observations of transient luminous events during the EuroSprite2003 campaign. Journal of Atmospheric and Solar-Terrestrial Physics 67, 807-820.

Nicolaou, H., Dendrinos, P., Marcou, M., Michaelides, S., Karamanlidis, A.A., 2021. Re-establishment of the Mediterranean monk seal Monachus monachus in Cyprus: priorities for conservation. Oryx 55, 526-528.

Nowak, K., 2012. Mangrove and peat swamp forests: refuge habitats for primates and felids. Folia Primatologica 83, 361-376.

Nowald, N., Iversen, M.H., Fischer, G., Ratmeyer, V., Wefer, G., 2015. Time series of in-situ particle properties and sediment trap fluxes in the coastal upwelling filament off Cape Blanc, Mauritania. Progress in Oceanography 137, 1-11.

Nyssen, J., Haile, M., Moeyersons, J., Poesen, J., Deckers, J., 2000. Soil and water conservation in Tigray (Northern Ethiopia): the traditional dagat technique and its integration with introduced techniques. Land Degradation & Development 11, 199-208.

Nyssen, J., Simegn, G., Taha, N., 2009. An upland farming system under transformation: proximate causes of land use change in Bela-Welleh catchment (Wag, Northern Ethiopian Highlands). Soil and Tillage Research 103, 231-238.

Odini, J., Kakembo, V., 2009. Comparison of pixel and sub-pixel based techniques to separate *Pteronia incana* invaded areas using multi-temporal high resolution imagery. Journal of Applied Remote Sensing 3, 033545.

Oeldenberger, S., Khaled, K.B., 2012. The African Geospatial Sciences Institute (agsi): a new approach to geospatial training in North Africa. ISPRS-International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences 39 -B6, 45-51.

Oke, A. O., Afolabi, A., 2014. Development of a robotic arm for dangerous object disposal. In 2014 6th International Conference on Computer Science and Information Technology (CSIT) (pp. 153-160).

Olabintan, O.D., Ajirotutu, J.O., 2012. Application of geographic information system (GIS) in tourism mapping for sustainable tourism development in Owo Local Government Area (LGA), Ondo State, Nigeria. In 4th International Conference on Education and New Learning Technologies (EDULEARN) (pp 55-65).

Oloo, O.J., 2017. Assessing the accuracy of remote sensing techniques in vegetation fractions estimation. South African Journal of Geomatics 6, 106-129.

Ortiz-Ruiz, A., Postigo, M., Gil-Casanova, S., Cuadrado, D., Bautista, J. M., Rubio, J. M., Luengo-Oroz, M., Linares, M., 2018. *Plasmodium* species differentiation by non-expert on-line volunteers for remote malaria field diagnosis. Malaria Journal 17, 54.

Otter, L.M., Macholdt, D.S., Jochum, K.P., Stoll, B., Weis, U., Weber, B., Scholz, D., Haug, G.H., Al-Amri, A.M., Andreae, M.O., 2020. Geochemical insights into the relationship of rock varnish and adjacent mineral dust fractions. Chemical Geology 551, 119775.

Packer, C., 2019. The African lion: a long history of interdisciplinary research. Frontiers in Ecology and Evolution 7, 259.

Pagabeleguem, S., Gimonneau, G., Seck, M.T., Vreysen, M.J.B., Sall, B., Rayaissé, J.B., Sidibé, I., Bouyer, J., Ravel, S., 2016. A molecular method to discriminate between mass-reared sterile and wild tsetse flies during eradication programmes that have a sterile insect technique component. PLoS Neglected Tropical Diseases 10, e0004491.

Pangau-Adam, M.Z., Brodie, J.F., 2019. Threats to the populations of two endemic brushturkey species in Indonesian New Guinea. Journal of Asia-Pacific Biodiversity 12, 488-492.

Pardo, L.E., Bombaci, S., Huebner, S.E., Somers, M.J., Fritz, H., Downs, C., Guthmann, A., Hetem, R.S., Keith, M., le Roux, A., Mgqatsa, N., Packer, C., Palmer, M.S., Parker, D.M., Peel, M., Slotow, R., Strauss, W.M., Swanepoel, L., Tambling, C., Tsie, N., Vermeulen, M., Willi, M., Jachowski, D.S., Venter, J.A., 2021. Snapshot Safari: A large-scale collaborative to monitor Africa's remarkable biodiversity. South African Journal of Science 117, 1-4.

Park, S., Aschenbach, K.H., Ahmed, M., Scott, W.L., Leonard, N.E., Abernathy, K., Marshall, G., Shepard, M., Martins, N.C., 2019. Animal-borne wireless network: remote imaging of community ecology. Journal of Field Robotics 36, 1141-1165.

Paschoal, A.M.O., Massara, R.L., Santos, J.L., Chiarello, A.G., 2012. Is the domestic dog becoming an abundant species in the Atlantic forest? A study case in southeastern Brazil. Mammalia 76, 67-76.

Pellikka, P.K., Lötjönen, M., Siljander, M., Lens, L., 2009. Airborne remote sensing of spatiotemporal change (1955–2004) in indigenous and exotic forest cover in the Taita Hills, Kenya. International Journal of Applied Earth Observation and Geoinformation 11, 221-232.

Pelta, R., Ben-Dor, E., 2019. Assessing the detection limit of petroleum hydrocarbon in soils using hyperspectral remote-sensing. Remote Sensing of Environment 224, 145-153.

Pinto, P.V., 2019. The giant sable antelope: Angola's national icon. In: Huntley, B.J., Russo, V., Lages, F., Ferrand, N., (eds). Biodiversity of Angola: science & conservation: a modern synthesis. Springer Nature, Cham. pp. 471-491.

Potash, A.D., Conner, L.M., McCleery, R.A., 2018. Extreme movements of an individual male Fox Squirrel. Southeastern Naturalist 17, N40-N43

Potash, A.D., Murphy, C.M., Pynne, J.T., McCleery, R.A., Conner, L.M., Castleberry, S.B., Smith, L.L., 2020. Eastern Fox Squirrel (*Sciurus niger*) observed using a Gopher tortoise (*Gopherus polyphemus*) burrow. Southeastern Naturalist 19, N14-N19.

Pynne, J.T., Stober, J.M., Edelman, A.J., 2020. Eastern Fox Squirrel (*Sciurus niger*) occupancy in fragmented montane longleaf pine forests. Southeastern Naturalist 19, 403-417.

Radebaugh, J., Lopes, R.M., Howell, R.R., Lorenz, R.D., Turtle, E.P., 2016. Eruptive behavior of the Marum/Mbwelesu lava lake, Vanuatu and comparisons with lava lakes on Earth and Io. Journal of Volcanology and Geothermal Research 322, 105-118.

Raimondi, V., Agati, G., Cecchi, G., Gomoiu, I., Lognoli, D., Palombi, L., 2009. In vivo real-time recording of UV-induced changes in the autofluorescence of a melanin-containing fungus using a micro-spectrofluorimeter and a low-cost webcam. Optics Express 17, 22735-22746.

Randhawa, N., Bird, B.H., VanWormer, E., Sijali, Z., Kilonzo, C., Msigwa, A., Ekiri, A.B., Samson, A., Epstein, J.H., Wolking, D.J., Smith, W.A., Martínez-López, B., Kazwala, R., Mazet, J.A.K., 2020. Fruit bats in flight: a look into the movements of the ecologically important *Eidolon helvum* in Tanzania. One Health Outlook 2, 1-14.

Rasmussen, G., Smultea, M., Cloutier, T., Giordano, A., Kaplin, B., Willey, L., 2021. Quantitative photogrammetric methodology for measuring mammalian belly score in the painted dog. PLoS One 16, e0261171.

Ratmeyer, V., Wefer, G., 1996. A high resolution camera system (ParCa) for imaging particles in the ocean: system design and results from profiles and a three-month deployment. Journal of Marine Research 54, 589-603.

Richardson, A.J., Everitt, J.H., Escobar, D.E., 1993. Reflectance calibration of aerial video imagery with automatic gain compensation on and off. International Journal of Remote Sensing 14, 2791-2801.

Ross, C.B., Gardner, W.D., Richardson, M.J., Asper, V.L., 2009. Currents and sediment transport in the Mississippi Canyon and effects of Hurricane Georges. Continental Shelf Research 29, 1384-1396.

Rothman, J.M., Chapman, C.A., Twinomugisha, D., Wasserman, M.D., Lambert, J.E., Goldberg, T.L., 2008. Measuring physical traits of primates remotely: the use of parallel lasers. American Journal of Primatology 70, 1191-1195.

Rovero, F., De Luca, D.W., 2007. Checklist of mammals of the Udzungwa Mountains of Tanzania. Mammalia 71, 47-55.

Rovero, F., Marshall, A.R., 2004. Estimating the abundance of forest antelopes by line transect techniques: a case from the Udzungwa Mountains of Tanzania. Tropical Zoology 17, 267-277.

Sakaue, J., Maeda, K., Miller, M.J., Sakai, R., Tahara, K.I., Abe, H., Maeda, K., Ida, H., 2021. New insights about the behavioral ecology of the coelacanth *Latimeria chalumnae* video recorded in the absence of humans off South Africa. Frontiers in Marine Science 8, 755275.

Sako, T., Nishimoto, K., Suzuki, D., Nagayama, T., Kurita, M., Naito, H., 2010. Search for High-z Afterglow Candidates in the Southern Sky by MOA-II and IRSF Telescopes. In International Symposium Deciphering the Ancient Universe with Gamma-Ray Bursts (Vol. 1279, pp 412-414).

Sambrook, K., Bonin, M.C., Bradley, M., Cumming, G.S., Duce, S., Andréfouët, S., Hoey, A.S., 2020. Broadening our horizons: seascape use by coral reef-associated fishes in Kavieng, Papua New Guinea, is common and diverse. Coral Reefs 39, 1187-1197.

Sarkar, D., Chapman, C.A., 2021. The smart forest Conundrum: Contextualizing pitfalls of sensors and AI in conservation science for tropical forests. Tropical Conservation Science 14, 1-11.

Schmeller, D.S., Böhm, M., Arvanitidis, C., Barber-Meyer, S., Brummitt, N., Chandler, M., Chatzinikolaou, E., Costello, M.J., Ding, H., García-Moreno, J., Gill, M., Haase, P., Jones, M., Juillard, R., Magnusson, W.E., Martin, C.S., McGeoch, M., Mihoub, J.B., Pettorelli, N., Proença, V., Peng, C., Regan, E., Schmiedel, U., Simaika, J.P., Weatherdon, L., Waterman, C., Xu, H., Belnap, J., 2017. Building capacity in biodiversity monitoring at the global scale. Biodiversity and Conservation 26, 2765-2790.

Semel, B.P., Karpanty, S.M., Vololonirina, F.F., Rakotonanahary, A.N., 2020. Eyes in the sky: assessing the feasibility of low-cost, ready-to-use unmanned aerial vehicles to monitor primate populations directly. Folia Primatologica 91, 69-82.

Seymour, C.L., Simmons, R.E., Morling, F., George, S.T., Peters, K., O'riain, M.J., 2020. Caught on camera: The impacts of urban domestic cats on wild prey in an African city and neighbouring protected areas. Global Ecology and Conservation 23, e01198.

Shahinfar, S., Meek, P., Falzon, G., 2020. "How many images do I need?" Understanding how sample size per class affects deep learning model performance metrics for balanced designs in autonomous wildlife monitoring. Ecological Informatics 57, 101085.

Shakmak, B., Al-Habaibeh, A., 2015. Detection of water leakage in buried pipes using infrared technology; a comparative study of using high and low resolution infrared cameras for evaluating distant remote detection. In 3rd IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT) (pp 1-7).

Smets, B., Michellier, C., Syavulisembo, A.M., Munganea, G., d'Oreye, N., Kervyn, F., 2018. Very High-Resolution Imaging of the City of Goma (North Kivu, DR Congo) Using SFM-MVS Photogrammetry. In 38th IEEE International Geoscience and Remote Sensing Symposium (IGARSS) (pp 3370-3373).

Stow, D., Hope, A., Richardson, D., Chen, D., Garrison, C., Service, D., 2000. Potential of colour-infrared digital camera imagery for inventory and mapping of alien plant invasions in South African shrublands. International Journal of Remote Sensing 21, 2965-2970.

Sumi, T., Yoneda, T., Fukuda, K., Hoshikawa, Y., Kobayashi, M., Yanagi, M., Kiuchi, Y., Yasumitsu-Lovell, K., Fukushima, A., 2013. Development of automated conjunctival hyperemia analysis software. Cornea 32, S52-S59.

Suraci, J.P., Clinchy, M., Mugerwa, B., Delsey, M., Macdonald, D.W., Smith, J.A., Wilmers, C.C., Zanette, L.Y., 2017. A new automated behavioural response system to integrate playback experiments into camera trap studies. Methods in Ecology and Evolution 8, 957-964.

Swanson, A., Kosmala, M., Lintott, C., Packer, C., 2016. A generalized approach for producing, quantifying, and validating citizen science data from wildlife images. Conservation Biology 30, 520-531.

Tabak, M.A., Norouzzadeh, M.S., Wolfson, D.W., Sweeney, S.J., VerCauteren, K.C., Snow, N.P., Halseth, J.M., Di Salvo, P.A., Lewis, J.S., White, M.D., Teton, B., Beasley, J.C., Schlichting, P.E., Boughton, R.K., Wight, B., Newkirk, E.S., Ivan, J.S., Odell, E.A., Brook, R.K., Lukacs, P.M., Moeller, A.K., Mandeville, E.G., Clune, J., Miller, R.S., 2019. Machine learning to classify animal species in camera trap images: applications in ecology. Methods in Ecology and Evolution 10, 585-590.

Taylor, P.J., Neef, G., Keith, M., Weier, S., Monadjem, A., Parker, D.M., 2018. Tapping into technology and the biodiversity informatics revolution: updated terrestrial mammal list of Angola, with new records from the Okavango Basin. ZooKeys 779, 51-88.

Telban, B., Vávrová, D., 2014. Ringing the living and the dead: mobile phones in a Sepik society. The Australian Journal of Anthropology 25, 223-238.

Thamm, H.P., 2011. SUSI62 a robust and safe parachute UAV with long flight time and good payload. In International Conference on Unmanned Aerial Vehicle in Geomatics (UAV-g) (Vol.38-1, pp 19-24).

Thomas, J., 2014. Fauna survey by camera trapping in the Torcelli Mountain Range, Papua New Guinea. In 1st International Colloquium on Camera Trapping in Wildlife Management and Research (pp 69-76).

Thomas, E., Gerster, S., Mugabo, L., Jean, H., Oates, T., 2020. Computer vision supported pedestrian tracking: A demonstration on trail bridges in rural Rwanda. PLoS One 15, e0241379.

Tobler, M.W., Carrillo-Percastegui, S.E., Pitman, R.L., Mares, R., Powell, G., 2008. An evaluation of camera traps for inventorying large-and medium-sized terrestrial rainforest mammals. Animal Conservation 11, 169-178.

Torralvo, K., Botero-Arias, R., Magnusson, W.E., 2017. Temporal variation in black-caiman-nest predation in varzea of central Brazilian amazonia. PLoS ONE 12, e0183476.

Tournadre, V., Labarta, C., Megard, P., Garric, A., Saubestre, E., Durand, B., 2017. COMPUTER VISION IN THE TEMPLES OF KARNAK: PAST, PRESENT & FUTURE. International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences 42, 357-364.

Tran, K., Ayad, M., Weinberg, J., Cherng, A., Chowdhury, M., Monir, S., El Hariri, M., Kovarik, C., 2011. Mobile teledermatology in the developing world: implications of a feasibility study on 30 Egyptian patients with common skin diseases. Journal of the American Academy of Dermatology 64, 302-309.

Trigo-Rodríguez, J.M., Castro-Tirado, A.J., Llorca, J., Fabregat, J., Martínez, V.J., Reglero, V., JelÌnek, M., Kubánek, P., Mateo, T., de Ugarte Postigo, A., 2005. The development of the Spanish Fireball Network using a new all-sky CCD system. In Meteoroids 2004 Conference (Vol. 95, pp 553-567).

Tuijn, C.J., Hoefman, B.J., Van Beijma, H., Oskam, L., Chevrollier, N., 2011. Data and image transfer using mobile phones to strengthen microscopy-based diagnostic services in low and middle income country laboratories. PLoS ONE 6, e28348.

Tye, C.A., Greene, D.U., Giuliano, W.M., Mccleery, R.A., 2015. Using camera-trap photographs to identify individual fox squirrels (*Sciurus niger*) in the Southeastern United States. Wildlife Society Bulletin 39, 645-650.

van Rooyen, J.M., Veltman, S., Botha, F., Matthee, J., 2021. Groundwater resource exploration & development–Focus on groundwater to support surface water supply in the Lower Olifants River, South Africa. Journal of African Earth Sciences 180, 104179.

Vardaro, M.F., Bagley, P.M., Bailey, D.M., Bett, B.J., Jones, D.O., Milligan, R.J., Priede, I.G., Risien, C.M., Rowe, G.T., Ruhl, H.A., Sangolay, B.B., Smith, Jr, K.L., Walls, A., Clarke, J., 2013. A Southeast Atlantic deep-ocean observatory: first experiences and results. Limnology and Oceanography: Methods 11, 304-315.

Vergara-Díaz, O., Zaman-Allah, M.A., Masuka, B., Hornero, A., Zarco-Tejada, P., Prasanna, B.M., Cairns, J.E., Araus, J.L., 2016. A novel remote sensing approach for prediction of maize yield under different conditions of nitrogen fertilization. Frontiers in Plant Science 7, 666.

Vitekere, K., Lango, L.M., Wang, J., Zhu, M., Jiang, G., Hua, Y., 2021. Threats to site occupation of carnivores: A spatiotemporal encroachment of non-native species on the native carnivore community in a human-dominated protected area. Zoological Studies 60, e52.

Vshivkova, T., Flint, O., Ito, T., Ivanov, V., Holzenthal, R., Melnitsky, S., Mey, W., Nozaki, T., Oh, M.W., Drozdov, K., Tojo, K., Saito, R., Tori, T., 2016. The list of caddisflies (Insecta, Trichoptera) collected in South Primorye during the symposium and post-symposium excursions of the XIV international symposium on Trichoptera (5 and 8− 13 July 2012). Zoosymposia 10, 64-84.

Wahab, I., Hall, O., Jirström, M., 2018. Remote sensing of yields: Application of UAV imagery-derived NDVI for estimating maize vigor and yields in complex farming systems in sub-saharan Africa. Drones 2, 1-16.

Walker, M.A., Uribasterra, M., Asher, V., Getz, W.M., Ryan, S.J., Ponciano, J.M., Blackburn, J.K., 2021. Anthrax surveillance and the limited overlap between obligate scavengers and endemic anthrax zones in the United States. Vector-Borne and Zoonotic Diseases 21, 675-684.

Waller, N.L., Gynther, I.C., Freeman, A.B., Lavery, T.H., Leung, L.K.P., 2017. The Bramble Cay melomys *Melomys rubicola* (Rodentia: Muridae): a first mammalian extinction caused by human-induced climate change? Wildlife Research 44, 9-21.

Whytock, R.C., Świeżewski, J., Zwerts, J.A., Bara-Słupski, T., Koumba Pambo, A.F., Rogala, M., Bahaa-el-din, L., Boekee, K., Brittain, S., Cardoso, A.W., Henschel, P., Lehmann, D., Momboua, B., Kiebou Opepa, C., Orbell, C., Pitman, R.T., Robinson, H.S., Abernethy, K.A., 2021. Robust ecological analysis of camera trap data labelled by a machine learning model. Methods in Ecology and Evolution 12, 1080-1092.

Wilbert, S., Röger, M., Csambor, J., Breitbach, M., Klinger, F., Nouri, B., Hanrieder, N., Wolfertstetter, F., Schüler, D., Shaswattam, S., Goswami, N., Kumar, S., Ghennioui, A., Affolter, R., Geuder, N., Kraas, B., 2018. Sunshape measurements with conventional rotating shadowband irradiometers. In 23rd International Conference on Concentrating Solar Power and Chemical Energy Systems (SolarPACES) (Vol. 2033, 190016-1).

Wrege, P.H., Rowland, E.D., Thompson, B.G., Batruch, N., 2010. Use of acoustic tools to reveal otherwise cryptic responses of forest elephants to oil exploration. Conservation Biology 24, 1578-1585.

Yaap, B., Watson, H., Laurance, W.F., 2015. Mammal use of *Raphia taedigera* palm stands in Costa Rica's Osa Peninsula. Mammalia 79, 357-362.

Yakovlev, R.V., Saldaitis, A., Rimsaite, J., Ivinskis, P., 2015. A new species of *Camellocossus* Yakovlev, 2011 (Lepidoptera: Cossidae) from southern Oman. Zootaxa 4013, 147-150.

Yonah, I.B., Mourice, S.K., Tumbo, S.D., Mbilinyi, B.P., Dempewolf, J., 2018. Unmanned aerial vehicle-based remote sensing in monitoring smallholder, heterogeneous crop fields in Tanzania. International Journal of Remote Sensing 39, 5453-5471.

Zefri, Y., ElKettani, A., Sebari, I., Ait Lamallam, S., 2018. Thermal infrared and visual inspection of photovoltaic installations by UAV photogrammetry—Application case: Morocco. Drones 2, 1-24.

CHAPTER 3

Influence of historical pressures on the vegetation characteristics between the wet and dry season and their impacts on the occupancy of bushbuck and Cape porcupine within the Southern Mistbelt Forests of KwaZulu-Natal, South Africa

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Running header: Influence of historical pressures on the microhabitat structure of forests

3.1 Abstract

The naturally fragmented Afromontane Southern Mistbelt forests of KwaZulu-Natal, South Africa, have experienced increased anthropogenic disturbances over the last 300 years, particularly between 1870 – 1944, in the form of intense logging and with continued use for subsistence. This can make it challenging to form effective conservation management strategies to conserve biodiversity in these forests. During the austral wet and dry seasons, we determined the microhabitat characteristics of state-owned and privately-owned forests and, whether inferences could be made as to which forests experienced historical pressures, and what these variations in microhabitat could mean for the occupancy of bushbuck (*Tragelaphus scriptus*) and Cape porcupine (*Hystrix africaeaustralis*). These species were chosen because of their difference in habitat preference (forest specialist vs. generalist) and activity periods (diurnal vs. nocturnal), with bushbuck being a diurnal forest specialist and Cape porcupine being a nocturnal generalist. We deployed 339 camera traps across 14 indigenous forest patches, of varying sizes, across three study areas in the KwaZulu-Natal Midlands area. At each camera trap location, we recorded habitat structure foliage profiles in a 20 m radius around the camera trap. Camera trap locations were sampled in the wet (October – April) and dry (May – September) seasons to determine the factors influencing bushbuck and Cape porcupine presence. Comparisons between historically logged privately-owned forests and state-owned forests indicated that the heavily logged forests had fewer trees higher than 20 m, indicating a reduced canopy height in these forests. Bushbuck was the most recorded mammalian species across both seasons, with significant differences in detection instances for Cape porcupine being recorded between the wet and dry seasons, which may be because of the forests being used for fluctuating food resources as well as being used as refugia from fires, with the generalist feeding nature of Cape porcupine’s making them non-reliant on forests. Evidence of overutilisation of forest resources by local people in the state-owned forests in Bulwer, coupled with hunting activities, may have resulted in the lowered naïve occupancies of bushbuck (wet season = 0.71, dry season = 0.56) and Cape porcupine (wet season = 0.26, dry season = 0.24) in these forests, compared with the bushbuck (wet season = 0.90, dry season = 0.85) and Cape porcupine (wet season = 0.37, dry season = 0.50) naïve occupancies experienced in privately-owned forests. Bare ground cover, short trees (2 – 5 m) and woody saplings (0 – 2 m) positively influenced the presence of bushbuck. The microhabitat variables influencing Cape porcupine were quite varied, presumably as they are a generalist species, feeding on whichever resources are available. This study highlighted the microhabitat differences between the historically pressured privately-owned and state-owned forest patches, showing the influence of these microhabitat differences on the presence of bushbuck and Cape porcupine, which contributes to the implementation of effective forest conservation management strategies.

Keywords Camera traps, Foliage profiles, Forest mammals, Historic pressures

3.2 Introduction

The effective functioning of natural ecosystems and the services they provide are negatively impacted by biodiversity loss (Mensah et al. 2020a), with the effects of habitat loss, habitat degradation and fragmentation on biodiversity being observed for several biomes and taxa (Fahrig 2003). One of the most important aspects of fragmentation relates to edge effects, which alter plant communities because of a change in available resources, microclimate or physical environments (Bach and Kelly 2004). The altering of plant communities also results from fragmentation, which interferes with pollination, whereby the number of flower visitors changes (Murcia 1996). The isolation of plant populations resulting from fragmentation not only results in a loss of species, but genetic variability is lost as well (Murcia 1996; Zambrano et al. 2019). The extinction of species in forest fragments is difficult to prevent, with certain species being certainly lost; however, with the adoption of appropriate management strategies, some species may persist in these fragmented landscapes (Murcia 1996; Grass et at. 2019; Arroyo-Rodríguez et al. 2020). The underlying mechanisms responsible for the ecological processes of forests have received little attention compared with ecosystems such as grasslands, with forests being highly complex, particularly in Africa, where these forests have unique vegetation diversity and complexity (Mensah et al. 2020a).

In these fragmented landscapes, the regeneration of tree species and tree recruitment (Lawes et al. 2007a) are vital for the survival of forests, with fragmentation effects impacting the availability of tree propagules and the abundances of seedlings, reducing the number of species and resulting in an altering of the community structure (Lawes et al. 2005a; Hill and Curran 2005). Forest fragmentation and the isolation of forest patches have the ability to strongly impact the persistence of tree species, particularly in small forest fragments (Lawes et al. 2007a). However, the rate at which the diversity of these plant species changes in these fragments is unknown, with research indicating that fragmentation significantly changes the tree species composition present in a forest, compared with the composition evident before disturbances occurred (Benítez-Malvido and Martínez-Ramos 2003). Fragmentation increases mortality rates of canopy trees in forest fragments, causing canopy gap formations (Laurance et al. 1997).

Tree species' persistence relies on the number of seeds, seedlings, and saplings available, which is considerably lower in forest fragments than in continuous forests (Benítez-Malvido and Martínez-Ramos 2003). In small forest patches, fragmentation results in higher tree mortalities and edge effects, with an alteration in plant-animal interactions (Lawes et al. 2005a). Human activities, such as logging and the clearing of forests for agriculture, have resulted in biodiversity loss (Geldenhuys 1997), which has severely impacted the integrity of these ecosystems, as well as their ability to provide valuable ecosystem services (Mensah et al.

2020b). This is particularly evident in the historically naturally fragmented Afromontane forests of South Africa, which experienced worsening fragmentation as a result of anthropogenic disturbances experienced over the last 300 years (Kotze and Samways 2001; Kotze and Lawes 2007). Destruction of these forests was particularly prominent during the period between 1870 and 1944, in the form of logging (Moll 1972; Wirminghaus et al. 1999), and increased agriculture and exotic commercial tree plantations, with the Karkloof forests estimated to cover only a quarter of their original area because of these activities (Wethered and Lawes 2003; Lawes et al. 2004; Adie et al. 2013). The logging activities experienced during this period were particularly focused on the felling of *Afrocarpus*/ *Podocarpus* spp., *Olea capensis*, *Ocotea bullata* and *Ptaeroxylon obliquum*, with the removal of these canopy trees resulting in an irregular forest canopy, which is still evident today (Moll 1972; pers. obs.). Coupled with the collection of timber, resources, such as poles, saplings and laths, were heavily exploited to build huts by local people (Moll 1972; Adie et al. 2013). These disturbances, coupled with unregulated harvesting and fire regimes (Mensah et al. 2020b), have resulted in many forest patches no longer being surrounded by natural grasslands but replaced with exotic tree plantations and alien vegetation (Wethered and Lawes 2003; Lawes et al. 2004; Taylor and Peacock 2018). These activities have resulted in the degradation of these forests, as many functions and services have been lost, with these disturbances further impacting the functioning and structure of the ecosystem, with factors such as resources and species interactions being altered as a result (Ghazoul et al. 2015).

Most commercial logging activities in these naturally fragmented forest Afromontane forests of South Africa have been banned since 1939 (King 1941), with several degraded areas having restored forest vegetation (Mensah et al. 2020b); however, many have not reached their previous quality in terms of canopy height nor successional stage (Moll 1972; Wirminghaus et al. 1999; Hart et al. 2013; pers. obs.). In areas, such as the Karkloof, the majority of the land became privately-owned since 1944, including the forested areas, with the state owning the remaining land (Weyer et al. 2015). This is true for most of the forests in the KwaZulu-Natal Midlands, with the majority of these forests being privately-owned (Bitani et al. 2023). Despite these forests being formally protected (privately-owned or state-owned) many of these forests, particularly the state-owned forests, are surrounded by communal land, with local communities relying on these forests for their livelihoods (Bitani et al. 2023). This resulted in a shift in disturbance from intense logging, during the colonial era, to resource extraction pressures, which is currently occurring in many of these forests, especially the state-owned forests, which are being exploited for fuelwood, food, traditional medicine and construction materials (Sosibo et al. 2022; Illukpitiya and Yanagida 2010; Lawes et al. 2005b). The frequent burning of the natural grasslands surrounding the forest is also responsible for forest destruction, and the winter grazing of cattle in the forests severely impacts regeneration (Moll 1972).

The disturbance forests have experienced is important to understand, as disturbed forests could negatively affect forest specialist species, as they are reliant on a more homogeneous environment, whereas disturbance could positively affect generalist species, which can use heterogenous environments (Lavery et al. 2020). Seasonality also impacts the forest specialist and generalist species differently, with factors such as food availability being impacted, by factors such as rainfall, with variations in seasons altering the microhabitat characteristics (Stoner and Timm 2011; Richard et al. 2022). When these food resources become limited, generalist species are able to alter their diets to the food sources available, whereas forest specialist species need to alter the preferred habitat within the forest patch, or leave the forest patch to seek more abundant food sources (Stoner and Timm 2011).

The Southern Mistbelt Forests are one of eight forest types found in South Africa, occurring from the Eastern Cape to the Midlands of KwaZulu-Natal (Symes et al. 2002; Mensah et al. 2020b). The sizes of these forests vary greatly because of their naturally fragmented nature, with patch sizes ranging from a few hectares to over 1000 ha (Symes et al. 2002). These forest patches provide vital socio-economic and ecological roles, as well as providing habitat for insect pollinators (Mensah et al. 2020b). The benefits these forests provide include fuel wood, medicinal resources, food, and controlling instances of biological invasions (Mensah et al. 2020b). These forests further play a vital role in reducing the impacts of climate change by being a carbon sink and providing watershed protection (Abiem et al. 2020; Mensah et al. 2020b).

It is challenging to form effective conservation management strategies to conserve the high biodiversity in these ecosystems because of the highly fragmented nature of South Africa's forests (Lawes et al. 2000b). Understanding the processes influencing forest landscape changes is vital for managing and conserving these forest areas, particularly in those anthropogenically modified environments, as these changes could result in fragmentation and habitat loss (Lawes et al. 2004; Rodríguez-Echeverry et al. 2018). It is vital to understand the floristic composition present in these forests to track the successional dynamics of forest vegetation to occurrences of various disturbances (Mensah et al. 2020b). By characterising the vegetation structures, an understanding of their dynamics could be achieved, which is useful when determining the effectiveness of enforced conservation measures, which could guide future management decisions (Mensah et al. 2020b; Gumede et al. 2022).

We aimed to determine the plant species richness (PSR) and habitat characteristics of naturally fragmented indigenous Afromontane Southern Mistbelt Forest patches of varying sizes in the KwaZulu-Natal Midlands. These were collected to infer whether the effects of historical pressures are still present in these forests and to determine whether particular characteristics could potentially indicate the pressures exerted on these forests. We further assessed what these characteristics could mean for species such as 1) a large-bodied, diurnal forest specialist (bushbuck *Tragelaphus sylvaticus*) and 2) a smaller nocturnal, generalist (Cape porcupine *Hystrix africaeaustralis*). We also assessed whether the impacts of these historical disturbances differ between state-owned and privately-owned forests, as well as the difference in habitat characteristics between the austral wet and dry seasons. We predicted that average tree heights would be shorter in historically intensely logged forest patches, particularly in the state-owned forests, with higher plant species richness in less disturbed forest patches. We also predicted that the state-owned forest patches would have lower naïve occupancies of bushbuck because of the predicted habitat disturbances, whilst Cape porcupines' naïve occupancy was predicted to be potentially higher in these state forests because of the increased edge effects. In terms of habitat structures, we predicted that the wet season would exhibit a higher percentage covers of herbaceous plants, grass and water than the dry season, which we predicted would have higher levels of leaf litter and bare ground compared with the wet season. Due to this, we predicted that bushbuck occupancy would be higher in the wet season because of a higher abundance of food resources, whereas Cape porcupine naïve occupancies would not display considerable variations because of their generalist feeding patterns.

3.3 Methods

3.3.1 Study area

The Afromontane Southern Mistbelt Forests are the oldest and most persistent forest type in South Africa, having been formed before the last glacial maximum (LGM), roughly 18,000 yr B.P. (Lawes et al. 2007b). These forests are considered naturally small and fragmented, occurring in a stable natural grassland matrix, with their distribution and size remaining fairly similar over the last 20,000 years (Lawes et al. 2000a; 2005a; Adie et al. 2013). The forests of this region have experienced fragmentation over most of their evolutionary history, primarily through considerable climatic changes during the Quaternary (Wethered and Lawes 2003; Griffiths and Lawes 2006). However, the fire-maintained grasslands, primarily comprising of

Themeda triandra, still dominate the majority of the Afromontane region (White 1978). The ecotones between the forests and grasslands are usually abrupt, occurring over 2-3 m (Lawes et al. 2005a), with these edges historically being maintained by natural fires; however, anthropogenic fires have recently been the primary source of maintenance (Kotze and Samways 2001). Exotic tree plantation was responsible for ~20% of the land transformation experienced in KwaZulu-Natal, with ~40% of the Karkloof – Balgowan forest regions experiencing this land transformation (Lawes et al. 2004). Since the 1940s, the forest area in the Midlands of KwaZulu-Natal has not changed considerably (Lawes et al. 2004).

Our study was conducted in the indigenous forest patches located between Karkloof (29°18'1.98" S, 30°20'25.66" E), located ~22 km North of Howick, and Bulwer (29°48' 28.54" S, 29°45' 32.79" E; Figure 3.1.), located ~38 km East of Underberg, in south-western KwaZulu-Natal. These forests fall under the Southern Mistbelt Forests in the KwaZulu-Natal Midlands, which are found between 1000 – 1500 m a.s.l., with the Karkloof forest being one of the largest Southern Mistbelt forests in Natal (Wirminghaus and Perrin 1993; Lawes et al. 2005a; Mucina et al. 2006). The forests occur on south-facing slopes, which receive approximately 1600 mm of rain annually, occurring primarily during the summer months, with temperatures ranging from -4 – 37 °C (Symes et al. 2002; Lawes et al. 2005a).

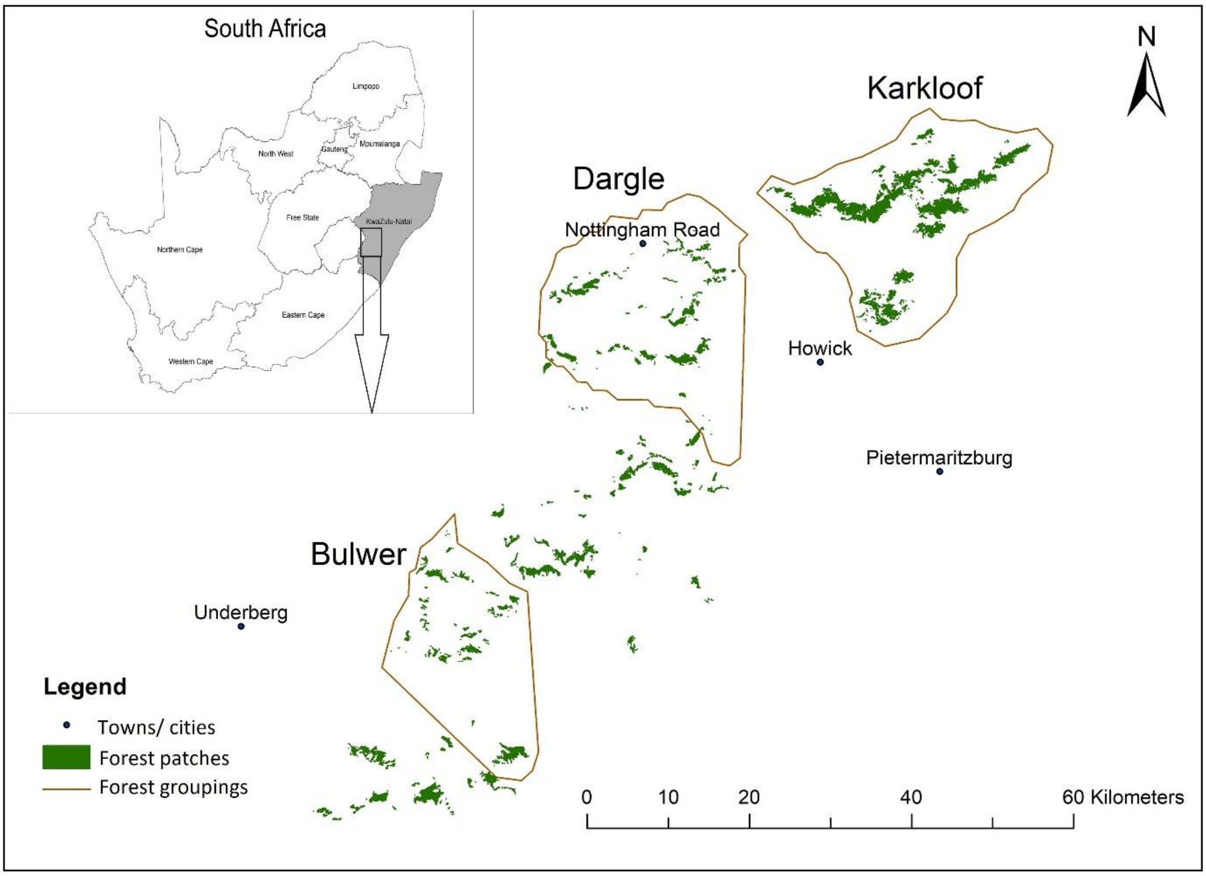

Figure 3.1: Study area, showing the locations of the indigenous forest patches selected within the Southern Mistbelt Forests between Karkloof (29°18'1.98" S, 30°20'25.66" E) and Bulwer (29°48' 28.54" S, 29°45' 32.79" E) in the Midlands of KwaZulu-Natal, South Africa.

The canopy heights in these Southern Mistbelt Forests generally range from 15-20 m (Wethered and Lawes 2003; Lawes et al. 2005a; Mucina et al. 2006), with some emergent trees reaching heights of 37 m (White 1978). The tree species in these forests are highly uniform, most defined by 12 tree species (White 1978). The dominant canopy tree species in these forests include *Xymalos monospora*, *Podocarpus falcatus*, *P. henkelii*, *P. latifolius*, *Celtis africana*, *Vepris lanceolata*, *Kiggelaria africana* and *Calodendrum capense* (Lawes et al. 2005a). The *Afrocarpus* and *Podocarpus* yellowwood species in these indigenous forests play a particularly important environmental and ecological role, as they provide food and suitable habitat for many mammalian and avian species, thereby contributing to the maintenance of biodiversity in these forest systems (Gumede et al. 2022). Generally, large yellowwoods are particularly scarce in those areas nearest to the once-populated areas of the early European settlers (Downs and Symes 2004). Various forest tree species continue to be exploited, for example, some for the medicinal value of their bark (Sosibo et al. 2022).

3.3.2 Survey site selection

We selected our survey sites using the geographic information system (GIS) software ArcGIS version 10.7 (ESRI, Redlands, CA, USA). Using the 2018 land cover map, we extracted all indigenous Southern Mistbelt Forests patches (Mucina et al. 2006) and selected only those patches greater than 0.5 ha. From the resulting layer, we categorised our study areas into three areas: Karkloof, Dargle and Bulwer, and selected forest patches of varying sizes and protection statuses in each area, comprising presently privately-owned forests and state-owned forests. We ensured that each area had a mainland forest patch, which was at least 90 ha, with the remaining selected forests being of varying size and distance from the mainland patch. This selection process resulted in 14 indigenous forest patches being selected for surveying, with four being in Karkloof, six in Dargle and four in Bulwer.

3.3.3 Camera trap surveys

The data on the occupancy of bushbuck and Cape porcupine, which were classified as a forest specialist (bushbuck) and a generalist (Cape porcupine), according to the information provided by literature (Skinner and Chimimba 2005), were obtained through a systematic camera trap survey we conducted between October 2020 and September 2021, which comprised of 184 passive infrared camera trap locations, with ~60 camera traps being installed at a time, across the 14 surveyed indigenous forest patches. The camera trap study was conducted for the wet season (October-April) and the dry season (May-September). Camera trap installation procedures and settings used followed those outlined by Ehlers Smith et al. (2017), whereby camera traps were deployed for at least 21 days, operating 24 h/day, with a 30 s motion detect trigger delay. The camera traps were deployed in a systematic 400 m x 400 m grid. To ensure the likelihood of the camera traps capturing passing wildlife, vegetation obscuring the sensor was removed, with the camera trap facing animal trails or gaps in vegetation which wildlife was likely to pass through. Camera traps were installed on a robust tree ~30 cm above the ground.

3.3.4 Habitat structure

We recorded the microhabitat characteristics at each survey site using the method outlined in Ehlers Smith et al. (2017) by noting woody plant species (including alien invasive species (Supplementary information Table S3.1), the average height of short grass and herbaceous plants (<25 cm), the average height of tall grass and herbaceous plants (>25 cm), the average height of woody plants (0-2 m) and maximum tree height, in a 20 m radius from the installed camera trap. We then noted the percentage cover of bare ground, leaf litter, short and tall grass, short and tall herbaceous plants, woody plants and water. We recorded the number of trees in each survey plot categorised by their height (2-5 m, 6-10 m, 11-15 m, 16-20 m, 20-25 m, >25 m). We recorded canopy openness, cover, and closure at each plot using the gap light analysis mobile application (GLAMA), an effective method of estimating canopy cover in forest environments (Tichý 2016).

3.3.5 Data analyses

We calculated the mean height recordings for each of the vegetation classes using the Shannon–Wiener formula ($H=-\sum[(pi)\times\ln(pi)]$) where pi is the proportion of total foliage occurring in the ith of the horizontal layers (Ehlers Smith et al. 2017; Bibby et al. 2000). All habitat variables incorporated into the occupancy modelling analysis (Table 3.1) were transformed into standardised z-scores, with potential correlations between independent variables being tested for multicollinearity, to avoid potential issues (Ramesh and Downs 2015; Ehlers Smith et al. 2017). Variables with VIF values exceeding 10 were deemed to be highly correlated (Alin 2010), with this study having a maximum VIF of 3, once correlated variables were removed. 13 variables remained in the wet and 15 in the dry season, once correlated variables were removed. The correlated variables removed were also based on the habitat preferences of the target species. For instance, herbaceous content was not removed for bushbuck, whereas it was removed for Cape porcupine.

To estimate the probability of a species occupying a site (ψ) and detection probabilities (p), we used the single-season occupancy model (MacKenzie et al. 2006) in the program PRESENCE 2.13.6 (Hines 2006). The detection histories for each identified mammalian species were recorded for the 21 days using a binary detection history (1 = present, 0 = absent). Detection histories for the wet and dry seasons were analysed independently.

We created a constant model in PRESENCE for each species (occupancy and detection probability were independent of the influence of covariates ($\Psi(.)P(.)$), with a model then being generated with all the microhabitat variables (Ehlers Smith et al. 2017). The impact of each variable was then modelled individually, with a combination of variables then being determined. Once the impacts of these variables were determined, variables were then modelled against ψ and p, to determine the factors most influential to the occupancy and detection probability of a particular species. This was determined by the model, which received the lowest Akaike's information criterion (AIC) value (Ramesh and Downs 2015; Ehlers Smith et al. 2017). Models which exhibited a deltaAIC (ΔAIC) value of ≤ 2 were prioritised and considered as possessing equal explanatory power (Ramesh and Downs 2015; Ehlers Smith et al. 2017).

Table 3.1: Microhabitat covariates included, after removal of correlated covariates, in the occupancy modelling of bushbuck (*Tragelaphus sylvaticus*) and Cape porcupine (*Hystrix africaeaustralis*) in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

Wet season		**Dry season**	
Covariate	**Abbreviation**	**Covariate**	**Abbreviation**
Heterogeneity Index	HI	Heterogeneity Index	HI
Bare ground (%)	BG	Bare ground (%)	BG
Leaf litter (%) (removed for bushbuck and porcupine)	LL	Leaf litter (%)	LL
Grass cover (%) (removed for bushbuck)	GC	Grass cover (%)	GC
Herbaceous cover (%) (removed for porcupine)	HC	Herbaceous cover (%)	HC
Sapling and short woody plants 0-2 m (%)	W0	Sapling and short woody plants 0-2 m (%)	W0
Water (%)	WA	Water (%)	WA
Stem density trees 2-5 m	SD2	Stem density trees 2-5 m	SD2
Stem density trees 6-10 m	SD6	Stem density trees 6-10 m	SD6
Stem density trees 11-15 m	SD11	Stem density trees 11-15 m	SD11
Stem density trees 16-20 m	SD16	Stem density trees 16-20 m	SD16
Stem density trees 20-25 m	SD20	Stem density trees 20-25 m	SD20
Stem density trees >25 m	SD25	Stem density trees >25 m	SD25
Plant species richness	PSR	Plant species richness	PSR
Canopy closure	CC	Canopy closure	CC

To determine the habitat variables with the most influence in the wet, dry, and both seasons combined, we performed an exploratory factor analysis (EFA), which is used to summarise any relationships among the included variables (Gorsuch 2013), thereby uncovering complex patterns (Yong and Pearce 2013). Before performing the EFA, we excluded those variables which indicated levels of multicollinearity too high (above 3) to perform the EFA (removed LL, GC and HI in the wet season and SD16 and HI in the dry season; no variables were removed in the analysis of both seasons combined).

By performing a principal components analysis (PCA) in R Studio (version 2023.6.0.0), we identified the factors responsible for a total variance of at least 50%, which is deemed a sufficient level of explained variance (Beavers et al. 2013). The PCA extracts the important information from the provided data and displays these variables as principal components, with the PCA displaying the patterns of similarity of the variables (Abdi and Williams 2010). To identify the number of factors to include in the factor analysis we performed a Cattell's scree plot in R Studio, using the factoextra package (Verzani 2011), which represents the factors with their associated eigenvalues (Beavers et al. 2013). Higher eigenvalues indicate high amounts of variance (Beaver et al. 2013), with this study only incorporating those factors to include in the factor analysis which had an eigenvalue greater than 1. An EFA was then run, based on the number of included factors, using the factional function in R. We chose to use an oblique rotation for this analysis, which aids in the simplicity of interpreting the data (Abdi 2003). Specifically, we used the PROMAX rotation, which has the advantage of being theoretically simple and fast, which could be interpreted by assessing the correlation between the variables and the axis, with the values of these correlations being termed as loadings (Abdi 2003). Based on these results, we extracted the factor scores, which provide information on the variables' placement in relation to the included factors (DiStefano et al. 2009). A common factor analysis was then performed, which enables the exploration of constructs which cannot be directly measured, which are responsible for the scores attributed to the variables (Beavers et al. 2013).

3.4 Results

3.4.1 Microhabitat structure

Due to camera trap malfunctions and theft, 164 out of 184 camera trap stations, and their corresponding microhabitat characteristics, were included for mammal occupancy and microhabitat analysis for the wet season, with a single camera trap (Waterfall) being excluded from the wet season because of camera malfunction, with 175 out of 184 camera trap stations and habitat characteristics being included in the dry season, resulting in a total of 339 camera trap stations in this study (Table 3.2). Karkloof had 181 camera trap locations across four forest patches, Dargle had 82 camera trap locations across six forest patches, and Bulwer received the remaining 76 camera trap locations across four forest patches.

Plant (tree) species richness (PSR) varied between forest sites (Supplementary Information Table S3.1), with a total of 44 tree species being recorded across all sites (Supplementary Information Table S3.2). Karkloof had the highest PSR of 42, with Dargle and Bulwer having a PSR of 36 and 32, respectively. Of these species, 32 were found across all study sites. The PSR also varied considerably between forest patches (Supplementary Information Table S3.3), with the highest PSR (38) being recorded at Mbona in the Karkloof, whilst the lowest PSR (8) was recorded at Waterfall in the Dargle. The average PSR across all study sites was 25.21. At each camera trap location, Bulwer had the highest average PSR across all forest patches with 9.31, followed by Karkloof with 7.7 and Dargle with 7.09.

Table 3.2: Sampling effort and location of each forest patch across the surveyed Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

Area	**Forest patch**	**Coordinates**	**Private/ state-owned**	**Number of functional cameras, and corresponding microhabitat data, out of the total number installed**	
				Wet season	**Dry season**
Karkloof	Mbona Private Nature Reserve	29°18’08” S; 30°22’26” E	Private	24 (28)	27 (28)
	Benvie Forest	29°15’27” S; 30°21’29” E	Private	8 (8)	8 (8)
	Karkloof Nature Reserve	29°17’50” S; 30°13’59” E	Private	45 (51)	49 (51)
	L'Abri Forest	29°17’08” S; 30°23’40” E	Private	10 (10)	10 (10)
Bulwer	Marutswa Forest	29°48’36” S; 29°47’25” E	State-owned	11 (11)	11 (11)
	Xotsheyake Forest	29°47’46” S; 29°47’16” E	State-owned	4 (5)	4 (5)
	Ingelebantwana Forest	29°43’43” S; 29°44’35” E	State-owned	9 (13)	12 (13)
	Nxumeni Forest	29°55’38” S; 29°50’42” E	State-owned	11 (14)	14 (14)
Dargle	Wakefield Forest	29°28’57” S; 29°53’44” E	Private	8 (9)	8 (9)
	Maritzdaal Forest	29°29’06” S; 30°02’57” E	Private	21 (21)	19 (21)
	Rameron Forest	29°20’34” S; 30°05’43” E	Private	8 (8)	8 (8)
	Milestone Forest	29°22’57” S; 30°05’40” E	Private	3 (3)	2 (3)
	Sharedown Forest	29°29’06” S; 29°54’28” E	Private	2 (2)	2 (2)
	Waterfall Forest	29°30’54” S; 29°54’18” E	Private	0 (1)	1 (1)
				Total = 164/184	**Total = 175/184**

Various microhabitat variables displayed considerable variations between forest patches in the wet and dry seasons (Tables 3.3 and 3.4). During the wet season, herbaceous cover was significantly higher than those recorded during the dry season for all forest patches, with the highest recordings being in Nxumeni. Grass cover percentages were generally higher during the wet season for most forest patches, with the Karkloof forests being the only patches exhibiting higher grass cover percentages during the dry season. The dry season showed significant increases in leaf litter coverage for the majority of forest patches, with Sharedown having the highest percentage coverage of leaf litter (82.1%). Bare ground coverage varied slightly between the wet and dry seasons, with the dry season generally exhibiting higher bare ground coverage than the wet season. Saplings and short woody plant cover displayed some variation between the wet and dry seasons, with the Karkloof having higher sapling and short woody plant cover during the wet season, whereas the remaining forest patches had higher coverage during the dry season.

When assessing the Z-scores of the microhabitat variables for each forest cluster (Figure 3.2), Bulwer had higher numbers of bare ground, particularly in the dry season, with Dargle having the lowest overall number. Leaf litter numbers were consistently low in Karkloof, with significant variation between Bulwer's wet and dry seasons, with the dry season having higher leaf litter percentages. Dargle had considerably higher leaf litter percentages, particularly in the dry season. Grass cover percentages were generally higher in the wet season, except for in the Karkloof, which exhibited higher grass cover percentages in the dry season. Bulwer exhibited the highest overall amount of herbaceous cover percentages. Overall percentages of sapling and short woody plants 0-2 m were significantly higher in the dry season in Bulwer, whereas stem density 2-5 m numbers were highest in Bulwer during the wet season. Karkloof and Dargle generally exhibited significantly lower stem density 2-5 m numbers than Bulwer, particularly in the wet season. However, Karkloof had disproportionally high numbers

Table 3.3: Average foliage profile recordings across all forest patches for the wet season in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

Microhabitat variables	**Karkloof**				**Bulwer**				**Dargle**				
	Mbona	**Benvie**	**KNR**	**L'Abri**	**Marutswa**	**Xotsheyake**	**Ingelebantwana**	**Nxumeni**	**Wakefield**	**Maritzdaal**	**Rameron**	**Milestone**	**Sharedown**
Heterogeneity Index	36.31	40.30	35.68	40.19	35.17	40.57	39.61	33.18	22.29	42.48	34.25	31.25	42.97
Bare ground (%)	6.05	6.16	4.33	1.03	4	4.13	3.36	6.95	3.59	3.38	4.41	6.92	2
Leaf litter (%)	25.12	16.38	22.09	14.78	12.20	17.25	16.06	12.36	25.38	27.85	49.13	16.42	41.63
Grass cover (%)	9.59	14.66	22.68	38.43	31.89	32.19	22.86	15.77	33.38	31.56	20.41	36.33	3.88
Herbaceous cover (%)	47.53	52.63	44.22	41.3	45.93	37.75	51.11	59.75	28.88	34.24	18.66	35.25	50.38
Saplings and short woody plants 0-2 m (%)	10.15	7.25	6.68	5.8	6.05	8.56	6.86	5.98	7.72	2.64	6.78	5.58	2.13
Water (%)	0.42	1.88	0.66	0.13	0	0	0	0.55	0	0.21	0	0	0
Stem density (SD) 2-5 m	23.35	19.25	32.98	30.8	41.45	42.25	25.67	18.55	31.38	28.62	24.13	19.67	29
Stem density (SD) 6-10 m	9.17	11.88	7.73	8.4	4.09	3.25	4.89	2.36	4.5	6.05	4.63	0.67	14
Stem density (SD) 11-15 m	4.91	6.13	5	2.5	2	1.75	2	0.45	1	15.19	5.88	1.67	20.5
Stem density (SD) 16-20 m	4.78	7	6.71	7.5	4.09	3.25	5	2.36	0.38	5.33	1.38	2.67	0
Stem density (SD) 20-25 m	1.26	4.63	1.18	3.5	0.73	6	4.22	2.55	0	0.14	0	0	0
Stem density (SD) >25 m	0.22	0.75	0.02	0.2	0	0	1	0.64	0	0	0	0	0
Plant species richness (PSR)	3.77	5.5	8.2	8.2	7.55	10.5	9.33	7	5.5	8.24	8.75	6	5
Canopy closure (CC)	85.07	83.27	84.03	85.03	87.32	89.74	88.21	88.73	86.15	89.25	90.95	85.48	90.27

Table 3.4: Average foliage profile recordings across all forest patches for the dry season in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

	Karkloof				Bulwer				Dargle					
Microhabitat variables	**Mbona**	**Benvie**	**KNR**	**L'Abri**	**Marutswa**	**Xotsheyake**	**Ingelebantwana**	**Nxumeni**	**Wakefield**	**Maritzdaal**	**Rameron**	**Milestone**	**Sharedown**	**Waterfall**
Heterogeneity Index	23.46	26.07	25.81	19.76	28.65	38.89	35.33	36.81	23.58	45.01	29.32	38.82	13.77	14.29
Bare ground (%)	4.91	7.78	3.71	1.53	4.84	4.75	3.54	8.36	3.66	4.62	6.34	3.88	2	4.5
Leaf litter (%)	39.55	30.34	30.87	27.33	35.80	47.38	33.48	26.70	46.16	31.09	48.44	24.88	82.13	67.75
Grass cover (%)	22.48	22.63	28.63	40.28	24.02	15.69	19.85	11.09	14.88	27.58	13.75	31.63	2	12
Herbaceous cover (%)	25.89	31.75	38.76	26.25	25.25	19.31	33.44	42.54	25.31	30.68	17.88	33.75	2.38	7.75
Saplings and short woody plants 0-2 m (%)	7.88	5.25	5.95	3.73	10.73	13.13	9.25	10.25	9.72	5.07	11.25	7.13	11.5	8
Water (%)	0.21	1.16	0.21	0	0.14	0.13	0.21	0.96	0.06	0	0	0	0	0
Stem density (SD) 2-5 m	20.11	23.5	24.57	18.7	22.55	26.75	23.5	18.57	20.88	14	19.5	12	40.5	18
Stem density (SD) 6-10 m	3.33	4.25	3.63	5.6	3.09	4	3.83	3.93	3.38	6.58	4.75	6.5	0	0
Stem density (SD) 11-15 m	1.41	1.38	3.22	0.8	1.18	1.75	3.42	1.86	0.25	2.89	0.38	2.5	0	0
Stem density (SD) 16-20 m	0.93	0.75	1.80	0.3	0.82	1.25	2.67	2.14	0	2.37	0.38	3.5	0	0
Stem density (SD) 20-25 m	0.15	0	0.04	0	0.09	0.25	0.17	0.21	0	0.21	0	0	0	0
Stem density (SD) >25 m	0	0	0	0	0	0	0	0.14	0	0	0	0	0	0
Plant species richness (PSR)	9.56	8.75	8.12	9.5	9.36	11.75	9.42	9.57	6.63	9.79	9.63	10	5.5	5
Canopy closure (CC)	90.36	88.54	91.95	90.69	88.24	85.52	88.42	84.23	87.29	88.54	88.85	84.89	80.80	93.01

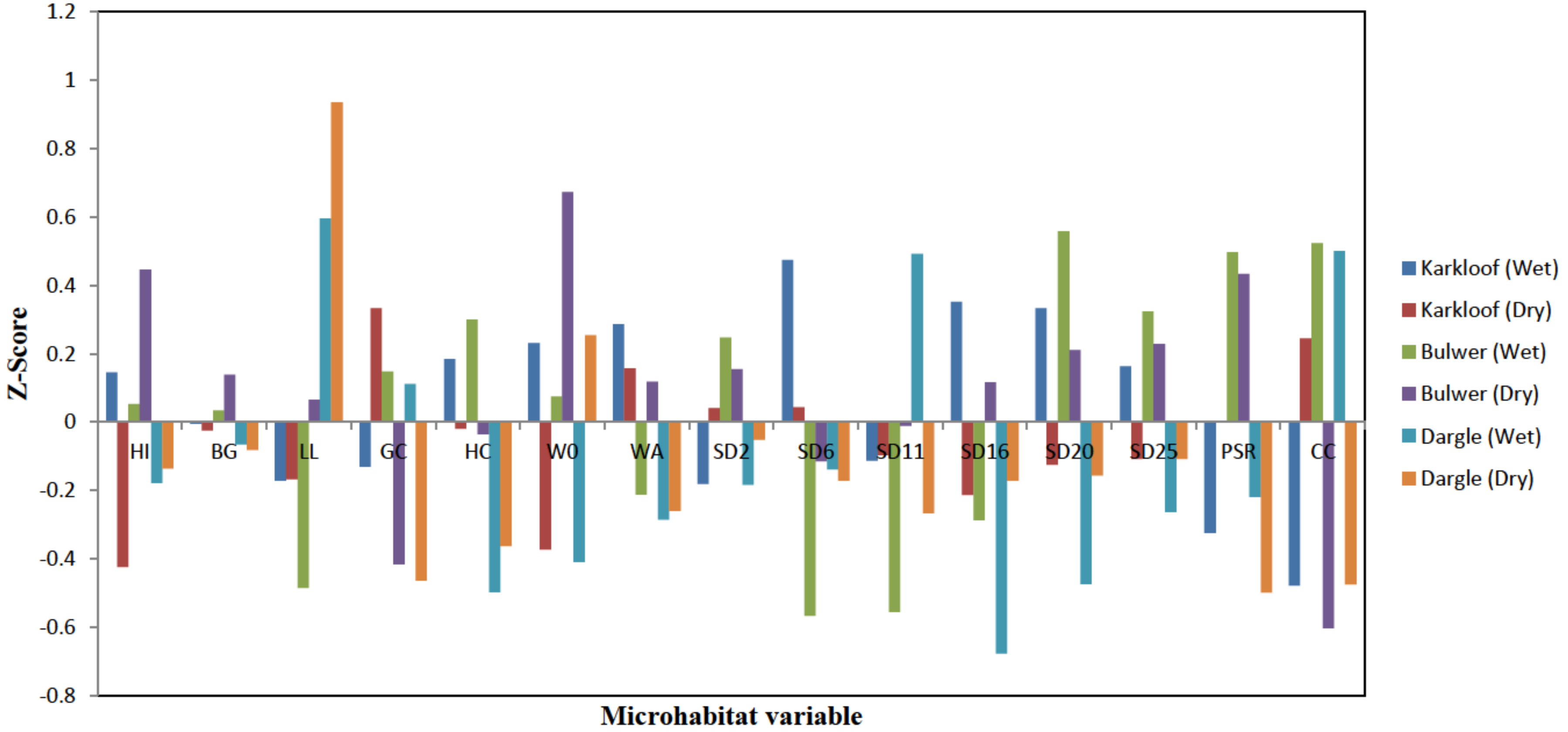

Figure 3.2: Microhabitat variable z-score variations between the Karkloof, Bulwer and Dargle forest clusters in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa. (Abbreviations: HI = heterogeneity index; BG = bare ground (%); LL = leaf litter (%); GC = grass cover (%); HC = herbaceous cover (%); W0 = saplings and short woody plants (%); WA = water (%); SD2 = stem density of trees 2–5 m; SD6 = stem density of trees 6–10 m; SD11 = stem density of trees 11–15 m; SD16 = stem density of trees 16–20 m; SD20 = stem density of trees 20–25 m; SD25 = stem density of trees >25 m; PSR = plant species richness; CC = canopy closure).

of stem density 6-10 m in the wet season than the other clusters, with Bulwer’s wet season having significantly lower numbers of stem density 6-10 m and stem density 11-15 m numbers. Stem density 16-20 m displayed the highest values in Karkloof’s wet season, whilst Bulwer displayed a significantly higher stem density 20-25 m in the wet season. Stem density >25 m numbers were highest overall in Bulwer. Canopy closure values varied considerably in all clusters, with canopy closure being generally higher in the wet season, as was evident in Bulwer and Dargle; however, Karkloof had significantly lower numbers in the wet season.

Between the state-owned and privately-owned forests, microhabitat variables exhibited certain variations between the wet and dry seasons (Figure 3.3; Table 3.5). Heterogeneity index and bare ground were significantly higher in state-owned forests, particularly during the dry season, with privately-owned forests displaying higher levels of leaf litter, particularly during the dry season. Grass cover varied in state-owned forests, with the dry season displaying a considerably lower percentage of grass cover. Herbaceous cover was considerably higher in the wet season in the state-owned forests, with the percentages being consistently lower in the wet and dry seasons in the privately-owned forests. Saplings and short woody plants 0-2 m were significantly higher in the state-owned forests, particularly during the dry season, with stem density 2-5 m numbers also being consistently higher in the state-owned forests during both seasons. However, the state-owned forests had considerably lower numbers of stem density 6-10 m and stem density 11-15 m in the wet season. Privately-owned forests had consistently low numbers of stem density 16-20 m, stem density 20-25, stem density >25 m and PSR, with state-owned forests exhibiting higher numbers of stem density 20-25, stem density >25 m and PSR, particularly during the wet season. Canopy closure varied between the wet and dry seasons for state-owned forests, with higher values being experienced during the wet season. Privately-owned forests also displayed a slight variation in canopy closure; however, higher values were found during the dry season.

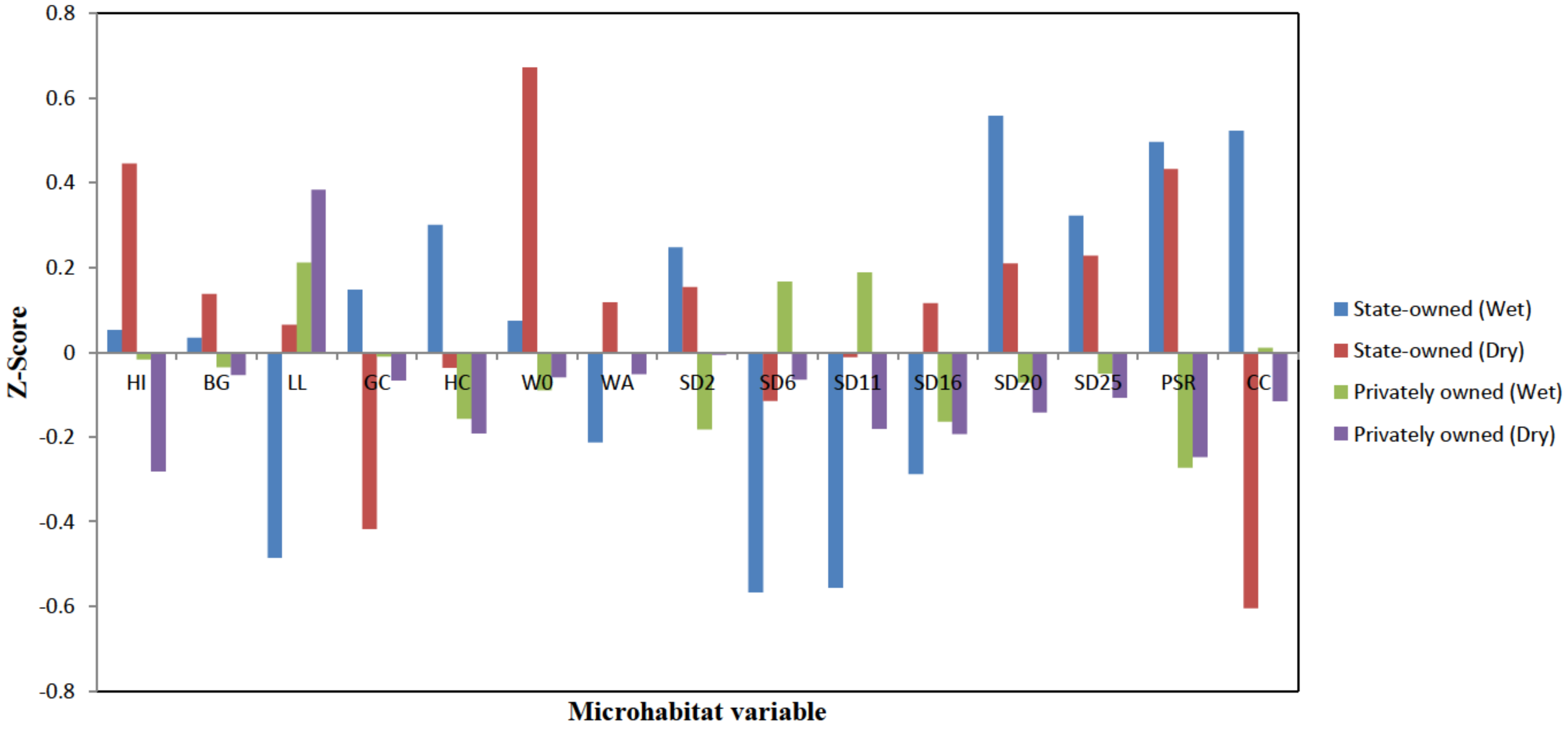

Figure 3.3: Microhabitat variable z-score variations between the Karkloof, Bulwer and Dargle forest clusters in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa. (Abbreviations: HI = heterogeneity index; BG = bare ground (%); LL = leaf litter (%); GC = grass cover (%); HC = herbaceous cover (%); W0 = saplings and short woody plants (%); WA = water (%); SD2 = stem density of trees 2-5 m; SD6 = stem density of trees 6-10 m; SD11 = stem density of trees 11-15 m; SD16 = stem density of trees 16-20 m; SD20 = stem density of trees 20-25 m; SD25 = stem density of trees >25 m; PSR = plant species richness; CC = canopy closure).

Table 3.5: Average foliage profile Z-score recordings, and their associated *P*-value, for state and privately-owned forests in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

Microhabitat variables	**State-owned (Wet season)**	***P*-value**	**State-owned (Dry season)**	***P*-value**	**Privately-owned (Wet season)**	***P*-value**	**Privately-owned (Dry season)**	***P*-value**
Heterogeneity Index	0.05	0.96	0.45	0.66	-0.02	0.99	-0.28	0.82
Bare ground (%)	0.03	0.97	0.14	0.89	-0.04	0.99	-0.05	0.94
Leaf litter (%)	-0.49	0.63	0.07	0.95	0.21	0.92	0.38	0.97
Grass cover (%)	0.15	0.88	-0.42	0.68	-0.01	1.00	-0.07	0.83
Herbaceous cover (%)	0.30	0.76	-0.04	0.97	-0.16	0.94	-0.19	0.99
Saplings and short woody plants 0-2 m (%)	0.07	0.94	0.67	0.50	-0.09	0.96	-0.06	0.74
Water (%)	-0.21	0.83	0.12	0.91	0.00	1.00	-0.05	0.95
Stem density (SD) 2-5 m	0.25	0.80	0.15	0.88	-0.18	0.93	-0.01	0.94
Stem density (SD) 6-10 m	-0.57	0.57	-0.11	0.91	0.17	0.93	-0.06	0.95
Stem density (SD) 11-15 m	-0.56	0.58	-0.01	0.99	0.19	0.92	-0.18	1.00
Stem density (SD) 16-20 m	-0.29	0.77	0.12	0.91	-0.16	0.94	-0.19	0.95
Stem density (SD) 20-25 m	0.56	0.58	0.21	0.83	-0.07	0.97	-0.14	0.92
Stem density (SD) >25 m	0.32	0.75	0.23	0.82	-0.05	0.98	-0.11	0.91
Plant species richness (PSR)	0.50	0.62	0.43	0.67	-0.27	0.89	-0.25	0.83
Canopy closure (CC)	0.52	0.60	-0.60	0.55	0.01	1.00	-0.12	0.76

3.4.2 Factor analysis on microhabitat variables

Based on Cattell's scree plot results (Supplementary Information Figure S3.1), for the microhabitat variables in the wet season, three factors were included, which had an eigenvalue greater than 1. The PCA scree plot and corresponding table displaying proportion variance explained for each component (Supplementary Information Figure S3.2) determined that three components were responsible for 70% of the explained variances for the wet season. The performed function analysis, using the PROMAX rotation (Figure 3.4) and common factor analysis (Figure 3.5), indicated the loading value association for each microhabitat variable (Supplementary Information Table S3.4).

These loadings indicated that factor 1 could relate to emerging trees, with stem density 20-25 m (0.95), stem density 16-20 m (0.69) and stem density >25 m (0.66) having high factor loadings. This indicated that when there were instances of tall emergent trees, there were fewer sub-canopy trees (11-15 m), indicated by the lower factor loading scores by this category (-2.5). PSR (0.78) and stem density 2-5 m (0.71) displayed high factor loading scores for factor 2, which could relate to disturbance and possible edge effects, with the highest PSR and stem density 2-5 m values being in Xotsheyake, with these factor loadings indicating that percentage bare ground cover is strongly negatively correlated with PSR and stem density 2-5 m. Stem density 6-10 m (0.99) and stem density 11-15 m (0.75) displayed high factor 3 loadings, which could be associated with the sub-canopy, indicating that bare ground coverage (-0.57) would generally be lower with an increasing sub-canopy.

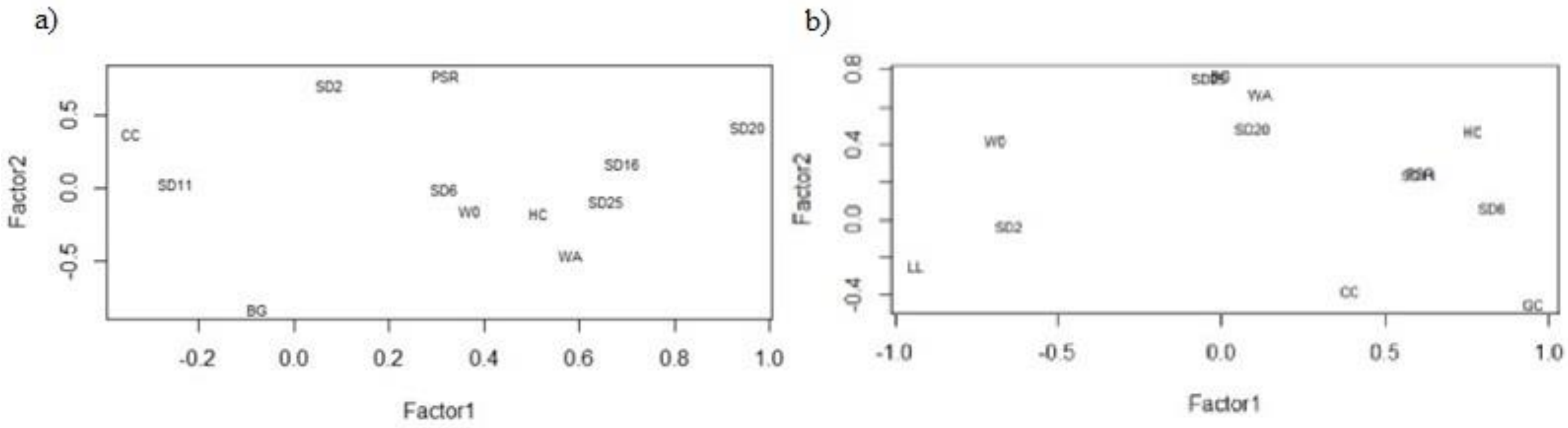

Figure 3.4: Factor analysis of microhabitat variables in the a) wet season, and b) dry season in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa. (Abbreviations: BG = bare ground (%); HC = herbaceous cover (%); LL = leaf litter (%); GC = grass cover (%); W0 = saplings and short woody plants (%); WA = water (%); SD2 = stem density of trees 2-5 m; SD6 = stem density of trees 6-10 m; SD11 = stem density of trees 11-15 m; SD16 = stem density of trees 16-20 m; SD20 = stem density of trees 20-25 m; SD25 = stem density of trees >25 m; PSR = plant species richness; CC = canopy closure).

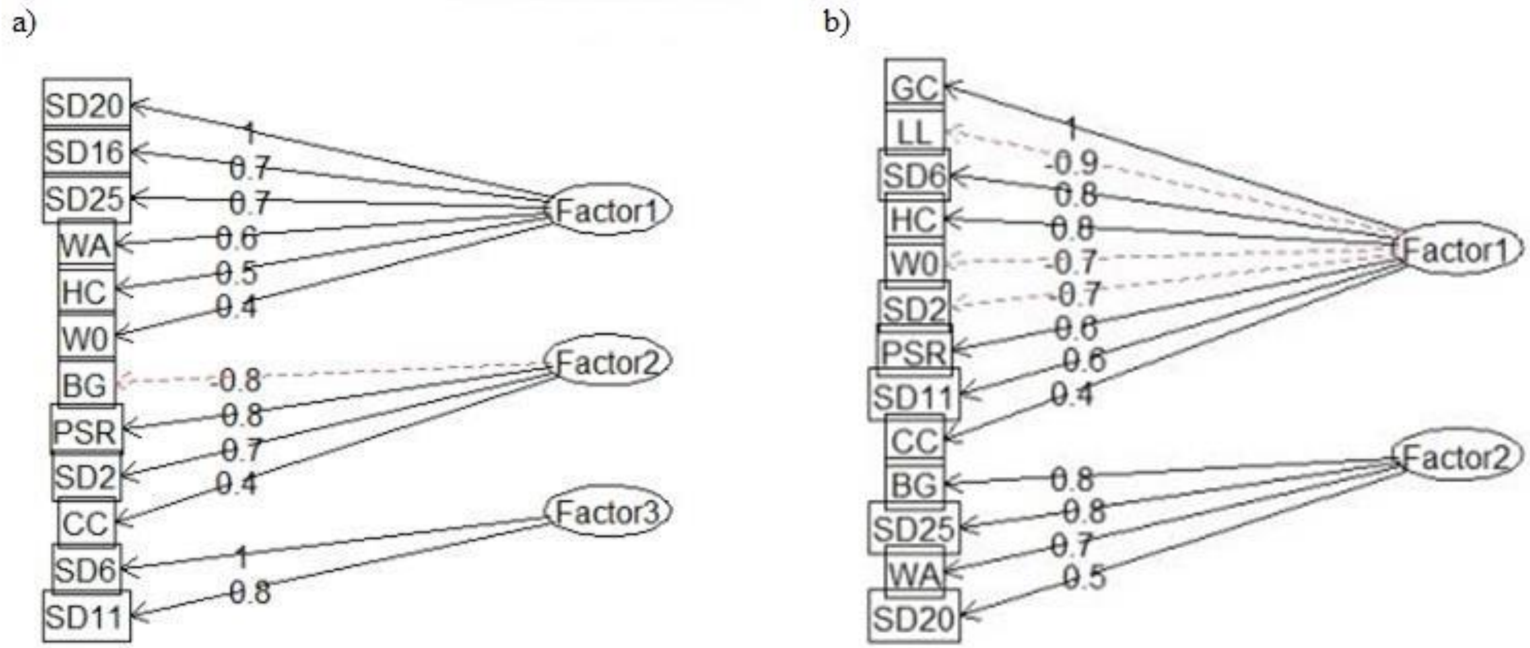

Figure 3.5: Common factor analysis of microhabitat variables in the a) wet season, and b) dry season in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa. (Abbreviations: BG = bare ground (%); HC = herbaceous cover (%); LL = leaf litter (%); GC = grass cover (%); W0 = saplings and short woody plants (%); WA = water (%); SD2 = stem density of trees 2-5 m; SD6 = stem density of trees 6-10 m; SD11 = stem density of trees 11-15 m; SD16 = stem density of trees 16-20 m; SD20 = stem density of trees 20-25 m; SD25 = stem density of trees >25 m; PSR = plant species richness; CC = canopy closure).

During the dry season, two factors exhibited eigenvalues greater than 1, with the PCA scree plot indicating that two components were responsible for 64% of the total explained variances. Factor analysis (Figure 3.4) and common factor analysis (Figure 3.5) indicated that grass cover (0.96), stem density 6-10 m (0.83) and herbaceous cover (0.77) had the highest factor loadings for factor 1, which could be associated with the sub-canopy and understory in the forest, with leaf litter (-0.93) being generally lower with an increased sub-canopy and understory coverage. Bare ground (0.77) and stem density >25 m (0.76) had the highest factor 2 loadings, indicating the relationship between tall emerging trees and bare ground coverage, with instances of tall emerging trees generally resulting in an increase in bare ground on the forest floor.

For both seasons, three factors had eigenvalues higher than one, with the total explained variance from the three components being 61%. Performed factor analysis (Figure 3.6) and common factor analysis (Figure 3.7) indicated that factor 1 loadings were highest for herbaceous cover (0.97), which could relate to the relationship between herbaceous cover and leaf litter (-1.03), indicating that when herbaceous cover is high, leaf litter coverage would be significantly lower. Only stem density 11-15 m (0.81) exhibited high factor 2 loading scores, relating to the sub-canopy of the forest, with saplings and short woody plants 0-2 m (-0.65) having a negative correlation with this variable, indicating that an increase in sub-canopy trees would result in fewer saplings and short woody plants 0-2 m (-0.65). No microhabitat variables indicated a particularly strong loading score on factor 3; however, stem density 11-15 m (0.51) and leaf litter (0.49) indicated a moderately positive loading score, which is associated with the relationship between the sub-canopy and the leaf litter on the forest floor, whereby higher leaf litter and sub-canopy coverage would generally result in lower grass cover (-0.98).

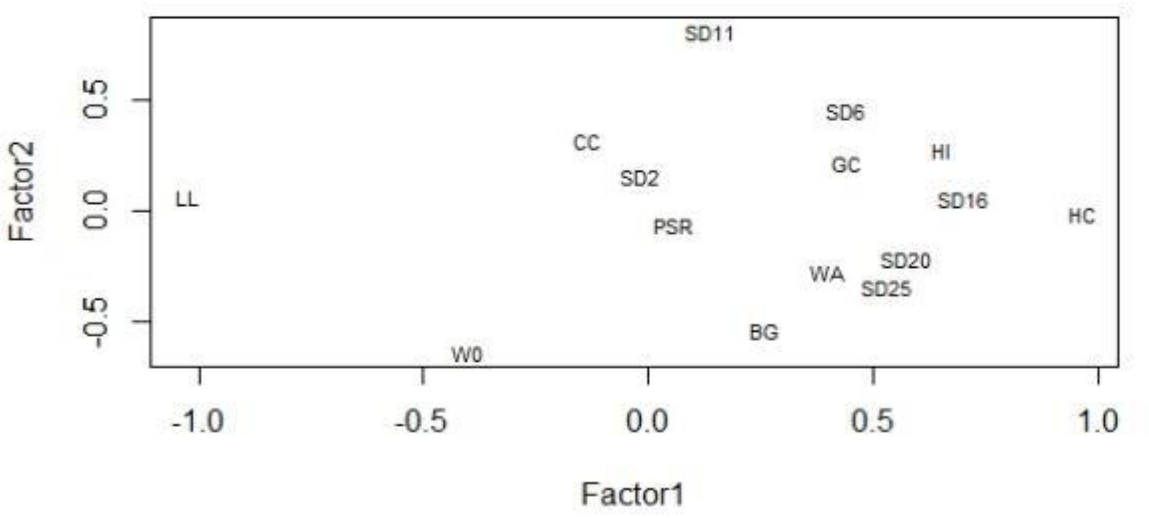

Figure 3.6: Factor analysis of microhabitat variables for both seasons combined in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa. (Abbreviations: HI = heterogeneity index; BG = bare ground (%); LL = leaf litter (%); GC = grass cover (%); HC = herbaceous cover (%); W0 = saplings and short woody plants (%); WA = water (%); SD2 = stem density of trees 2-5 m; SD6 = stem density of trees 6-10 m; SD11 = stem density of trees 11-15 m; SD16 = stem density of trees 16-20 m; SD20 = stem density of trees 20-25 m; SD25 = stem density of trees >25 m; PSR = plant species richness; CC = canopy closure).

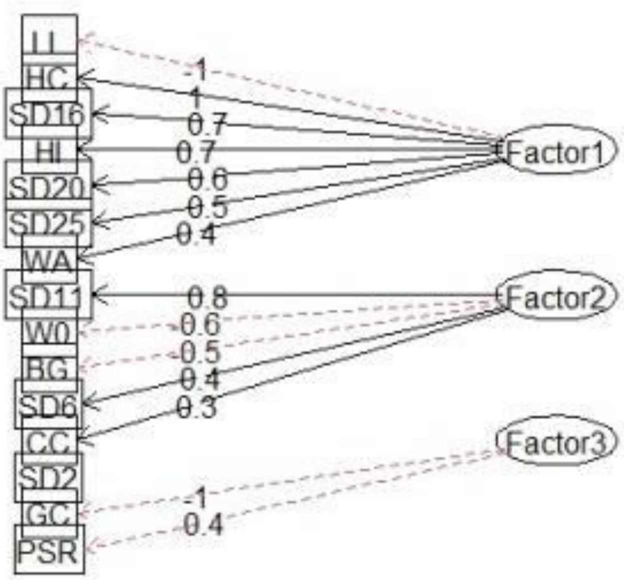

Figure 3.7: Common factor analysis of microhabitat variables for both seasons combined in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa. Abbreviations: HI = heterogeneity index; BG = bare ground (%); LL = leaf litter (%); GC = grass cover (%); HC = herbaceous cover (%); W0 = saplings and short woody plants (%); WA = water (%); SD2 = stem density of trees 2-5 m; SD6 = stem density of trees 6-10 m; SD11 = stem density of trees 11-15 m; SD16 = stem density of trees 16-20 m; SD20 = stem density of trees 20-25 m; SD25 = stem density of trees >25 m; PSR = plant species richness; CC = canopy closure.

3.4.3 Occupancy of bushbuck and Cape porcupine

A total of 3215 trap days were conducted in the wet season, with the dry season having 3551 trap days, resulting in a total sampling effort of 6766 trap days across both seasons, with these seasonal totals differing as a result of higher numbers of malfunctioned and stolen camera traps during the wet season. The most frequently captured species in the wet and dry seasons were bushbuck (n = 1126) and Cape porcupine (n = 353, Supplementary Information Table S3.5). During the wet season, Karkloof had the highest number of captures of bushbuck on camera traps (296), followed by Dargle (168) and Bulwer (52). From the camera trap stations deployed in each cluster in the wet season, Dargle had the highest naïve occupancy of bushbuck (0.93; Figure 3.8; Supplementary Information Table S3.6), followed by Karkloof (0.87) and Bulwer (0.71). Overall, the privately-owned forests had considerably higher naïve occupancies of bushbuck (0.90), compared with those in state-owned forests (0.71), during the wet season. Karkloof had the highest instances of bushbuck captures on camera traps during the dry season (325), followed by Dargle (219) and Bulwer (66). During the dry season, Karkloof and Dargle both had the highest naïve occupancies of bushbuck (0.85), followed by Bulwer (0.56). Privately-owned forests had considerably higher naïve occupancies of bushbuck in the dry season (0.85) than the state-owned forests (0.56).

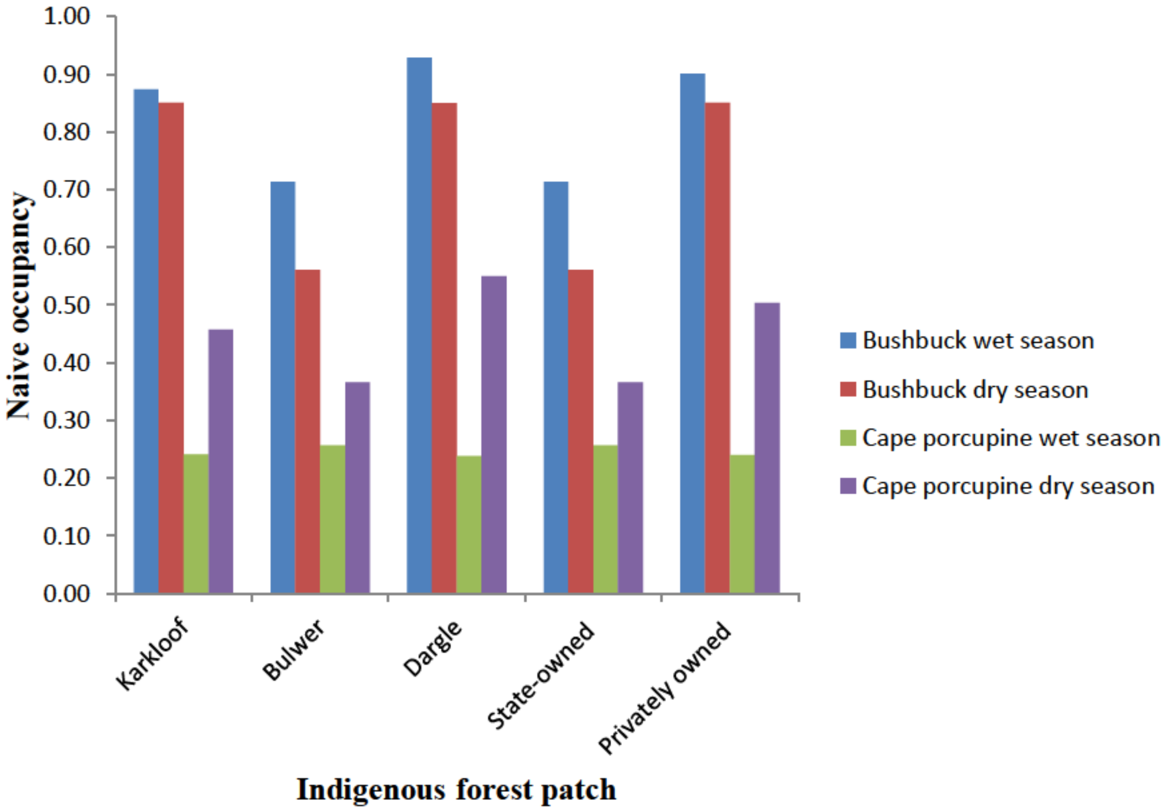

Figure 3.8: Naïve occupancies of bushbuck *Tragelaphus sylvaticus* and Cape porcupine *Hystrix africaeaustralis* across all forest clusters and state-owned and privately-owned forests, for the wet and dry seasons, in the midlands of KwaZulu-Natal, South Africa.

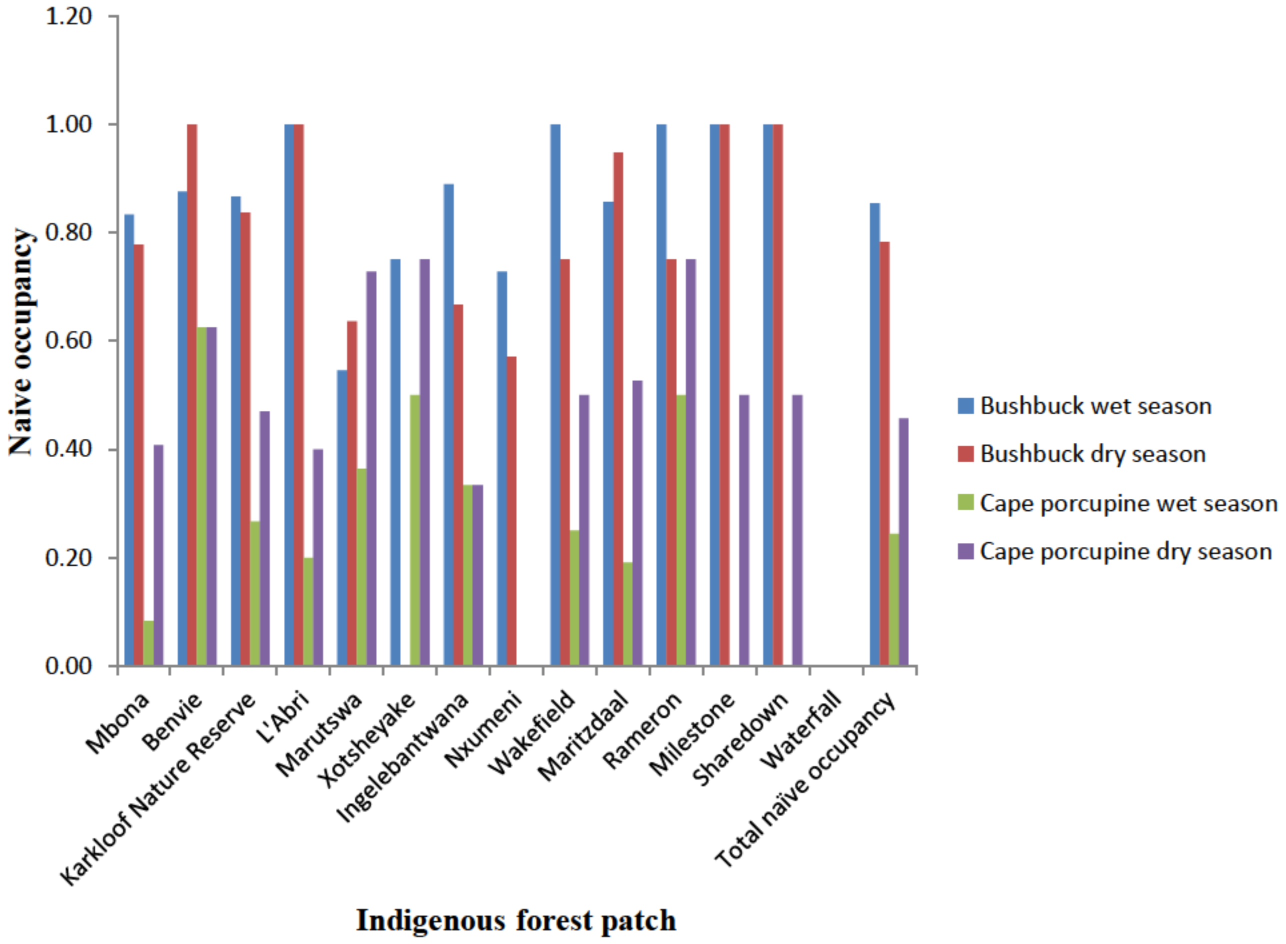

Figure 3.9: Naïve occupancies of bushbuck *Tragelaphus sylvaticus* and Cape porcupine *Hystrix africaeaustralis* across all forest patches for the wet and dry seasons in the midlands of KwaZulu-Natal, South Africa.

Naïve occupancies per forest patch in the wet season (Figure 3.9; Supplementary Information Table S3.7) for bushbuck showed that L'Abri, Wakefield, Rameron, Milestone and Sharedown all had a naïve occupancy of one. Ingelebantwana (0.89), Benvie (0.88), Karkloof Nature Reserve (0.87) and Maritzdaal (0.86) also displayed high naïve occupancies of bushbuck in the wet season. In the wet season, the lowest recordings of bushbuck naïve occupancies were found in Marutswa (0.55), which was significantly lower than the second-lowest values experienced in Nxumeni (0.73).

During the dry season, Benvie, L’Abri, Milestone and Sharedown had a naïve occupancy for bushbuck of one, with the naïve occupancies generally not displaying considerable variations between seasons for the majority of forest patches. However, notable variations were observed in Ingelebantwana, Wakefield, Rameron, Nxumeni and Xotsheyake, whereby naïve occupancies of bushbuck were considerably lower in the dry season, with Xotsheyake having a naïve occupancy of zero.

For Cape porcupines, during the wet season, Karkloof had the highest number of captures on camera traps (51), followed by Dargle (33) and Bulwer (22). From the camera trap stations deployed in each cluster in the wet season, naïve occupancies of Cape porcupine were highly similar between the forest clusters, with Bulwer having a slightly higher naïve occupancy (0.26) compared with Karkloof and Dargle (0.24), meaning the state-owned forests experienced a slightly higher naïve occupancy of Cape porcupine compared with the privately-owned forests. During the dry season, all forest clusters experienced a considerable increase in naïve occupancy of Cape porcupine, particularly in Dargle, which displayed a rise in values from 0.24 in the wet season to 0.55 in the dry season, making it the forest cluster with the highest naïve occupancy value in the dry season. Karkloof also exhibited considerably higher naïve occupancies in the dry season (0.46), with Bulwer having the lowest experienced naïve occupancy (0.37). This meant privately-owned forests had considerably higher naïve occupancies during the dry season (0.50) than state-owned forests (0.37).

Naïve occupancies per forest patch in the wet season for Cape porcupines showed that the highest values were at Benvie (0.63), Xotsheyake (0.50) and Rameron (0.50). Several forest patches experienced no recordings (Nxumeni, Milestone and Sharedown), with naïve occupancies across the remaining sites generally low (<0.30). During the dry season, however, most sites experienced a rise in Cape porcupine naïve occupancy, with a few sites (Benvie, Ingelebantwana and Nxumeni) having the same naïve occupancy values as the wet season. The highest values were experienced in Rameron (0.75), Xotsheyake (0.75) and Marutswa (0.73), with no recordings being experienced at Waterfall and Nxumeni. The remaining sites all displayed naïve occupancies higher than 0.30.

The top models for bushbuck and Cape porcupine (Table 3.6) demonstrated the microhabitat variables most influential to a particular species' occupancy and detection probability. During the wet season, the top model for bushbuck indicated a detection probability of 0.18, with the dry season exhibiting a higher detection probability of 0.23. The top models for Cape porcupine showed a more consistent detection probability between the wet (0.14) and dry (0.15) seasons. Bare ground positively influenced the occupancy probability of bushbuck in the wet and dry seasons (Supplementary Information Table S3.8). Bare ground, however, negatively influenced the detection probability of these species, except for bushbuck during the dry season. Other microhabitat variables influencing the occupancy probability of these species varied, even for the same species between seasons; however, bushbuck and Cape porcupine were influenced by the stem density of trees, which varied in length, with canopy closure also having a positive influence on the occupancy probability of Cape porcupine in the dry season.

Canopy closure positively influenced the detection probability of bushbuck, with water positively influencing the detection probability of these species, except bushbuck during the dry season. The heterogeneity index also positively influenced the detection probability of bushbuck during both seasons, with Cape porcupine’s detection probability only being positively influenced by the heterogeneity index during the wet season. Grass cover, leaf litter and plant species richness positively influenced the detection probability of bushbuck and Cape porcupine during the dry seasons, with stem density of trees, of varying lengths positively influencing the detection probability of all species across both seasons.

Table 3.6: The top models indicating the microhabitat variables most influential to the occupancy and detection probabilities of bushbuck *Tragelaphus sylvaticus* and Cape porcupine *Hystrix africaeaustralis* across all forest patches for the wet and dry seasons in the midlands of KwaZulu-Natal, South Africa.

Species	**Model**	**AIC**	**Delta AIC**	**AIC wgt.**	**Model likelihood**	**No. Par**	**2*log like**	***Ψ*±SE**	***p*±SE**
Bushbuck (wet)	psi(HI+BG+SD2+WA),p(HC+WA+CC+SD2+SD25+HI)	2735	0.00	0.41	1.00	12	2711.00	0.88±0.025	0.18±0.008
Bushbuck (dry)	psi(W0+SD25+BG),p(CC+SD16+GC+SD25+BG+SD20+PSR+HI+LL+SD2+SD6)	3052.66	0.00	0.08	1.00	16	3020.66	0.78±0.049	0.23±0.026
Porcupine (wet)	psi(SD11+PSR),p(WA+SD11+SD16+W0+SD2+SD6+HI+SD25)	782.42	0.00	0.24	1.00	12	758.42	0.29±0.041	0.14±0.012
Porcupine (dry)	psi(SD2+CC),p(LL+SD6+GC+WA+SD11+PSR)	1598.99	0.00	0.08	1.00	10	1578.99	0.5±0.065	0.15±0.024

Abbreviations: BG = bare ground (%); WA = water (%); HC = herbaceous cover (%); GC = grass cover (%); LL = leaf litter (%); CC = canopy closure; PSR = plant species richness; HI = heterogeneity index; W0 = saplings and short woody plants (%); SD2 = stem density of trees 2-5 m; SD6 = stem density of trees 6-10 m; SD11 = stem density of trees 11-15 m; SD16 = stem density of trees 16-20 m; SD20 = stem density of trees 20-25 m; SD25 = stem density of trees >25 m.

3.5 Discussion

3.5.1 Plant microhabitat structure

For each of the forest clusters, the collected microhabitat results indicated that the prediction that the wet season would exhibit a higher percentage of herbaceous cover was correct, with all forest clusters having significantly higher herbaceous cover during the wet season than the dry season. This is most likely because of the higher rainfall these forests receive during the wet season, with herbaceous cover percentages between seasons being primarily determined by the variation in rainfall these sites receive (Buitenwerf et al. 2011). For grass cover, most forest clusters exhibited a higher percentage of grass cover during the wet season, with Karkloof being the only cluster displaying a lower percentage of coverage during the wet season. Grass cover in these forests is likely able to persist during the dry season as a result of the opening of the canopy because of leaf shedding (de Souza et al. 2004), which is observed in the forest clusters, whereby leaf litter was considerably higher in these forests during the dry season, confirming our prediction. The assumption that water cover would be higher in the wet season because of the majority of rainfall occurring during this period (Symes et al. 2002; Lawes et al. 2005a) was mostly true, except for Bulwer during the dry season, as there was significant snowfall in these forests during this period. This also resulted in considerable water cover in Karkloof during the dry season as well; however, water cover in Dargle remained low as snow was not present during sampling. Bare ground percentage cover displayed a slightly higher percentage cover in the dry season for all forest clusters.

Plant species richness varied between study sites; however, most tree species were shared between sites. Tree species diversities were considerably less than those recorded in studies conducted in the Coastal Belt Forest, with a study conducted by Ehlers Smith et al. (2017) identifying a total of 193 plant/ tree species in the forest habitat compared with the 44 plant/ tree species identified in this study. Compared with the lowland forests, Afrotemperate forests have significantly fewer tree flora, with these forests exhibiting considerably high levels of homogeneity and uniformity, with low endemism (Adie et al. 2017).

The Afromontane forests sampled in this study have experienced varying levels of human disturbances, with each forest's floristic variations possibly being determined by each forest's ability to respond to disturbances and regenerate (Everard 1992). The Afromontane forests in the study area have been naturally fragmented, which has been worsened through human activities, with these forests consisting of several large patches to multiple small patches, roughly 1 ha in size, which have been heavily logged in the past (Wethered and Lawes 2003; Downs and Symes 2004; Grieve and Downs 2015; Cooper et al. 2017). This is particularly true for the forests in Karkloof and Balgowan, which are estimated to be about 40% of their original size as a result of the extensive logging activities conducted from 1860 to 1940 by colonial settlers (Lawes et al. 2000b; Adie et al. 2013; Grieve and Downs 2015). Some of these forests are still harvested despite their protection status, with a forest department being established in 1902 (Grieve and Downs 2015). The structure and compositions of these forests have been shaped by the severe logging activities experienced during this period, resulting in a change in the species composition within these disturbed forests (Lawes et al. 2007a; Adie et al. 2013). Despite the known occurrence of logging activities in several of the sampled forest patches, the results from GLAMA did not produce results indicative of these activities; however, the assessment of stem densities between historically logged forests and those less disturbed forests, particularly those trees taller than 20 m, are quite apparent.

The effects of extensive logging on the forests in this study could be identified through the heights of the canopy trees, recorded in a 20 m radius plot at each survey site. Bulwer exhibited, on average, the most trees in the 20-25 m (1.78) and >25 m (0.22) tree height categories, followed by Karkloof (20-25 m = 1.34; >25 m = 0.15) and Dargle (20-25 m = 0.03; >25 m = 0.00). Aerial photographs of the Karkloof forests have indicated that the canopies in the forests have become more uneven with more gaps, which is the result of the removal of the large canopy trees, particularly the large *Afrocarpus*/*Podocarpus* spp., during this period of heavy logging (Lawes et al. 2004; Downs and Symes 2004; Grieve and Downs 2015). The removal of these canopy trees has been suggested to result in a 40 % reduction in mean canopy height, with these structural modifications likely to affect the ecology of these forests (Downs and Symes 2004). This would coincide with previous studies suggesting that tree regeneration can be relatively slow following logging events, taking multiple decades (Qie et al. 2019) or even ceasing, which could reduce conservation value for these heavily disturbed forests (Lawes and Chapman 2006). These differences between stem densities higher than 20 m are also observable between state-owned and privately-owned forests, as is apparent from the factor analysis results, whereby the extensively logged privately-owned forests all displayed lower stem densities of trees higher than 20 m, compared with the state-owned forests, which were not as extensively logged, with privately-owned forests exhibiting no trees higher than 25 m during the dry season.

The disturbances faced by these forests could be one of the possible reasons plant/ tree species richness per camera trap site was lowest in the Dargle (7.09) and Karkloof (7.7) forests, with Bulwer (9.31), which were all state-owned forests, having the highest plant/ tree species richness per camera trap site. However, protected areas, such as Mbona Private Nature Reserve in Karkloof, which was declared a protected area under national legislation (Carbutt and Martindale 2014), had the highest plant/ tree species richness (38), along with the Karkloof Nature Reserve (36), indicating that the persistence of many species can be affected by habitat protection, as well as the restoration of habitat (Crouzeilles et al. 2015).

Although many of the forests in this study have been protected since the logging by colonial settlers and are presently managed by Ezemvelo KwaZulu-Natal Wildlife (EKZNW), since the 1980s, uncontrolled collection of natural resources is still prevalent in many of these forests (Lawes et al. 2007a; Adie et al. 2013; pers. obs.). This was particularly evident in the forests of Marutswa and Xotsheyake, and in some sections of Nxumeni, in Bulwer, where local residents were frequently seen harvesting natural resources, such as firewood and building materials from the forests (pers. obs.). These forests have also been exploited for plants used in traditional medicines, as well as bark stripping, which play an important role in the lives of people in rural communities (Cunningham 1991), with frequent sightings of domestic mammals, such as cattle (*Bos taurus*) and dogs (*Canis familiaris*), being observed on our camera traps, as well as during our fieldwork, particularly in Marutswa and Xotsheyake. The presence of cattle could be particularly destructive for these forests, as they cause damage to the forest margin through trampling and overgrazing (Cooper and Moll 1968; Wirminghaus and Perrin 1993; Fremout et al. 2020), which was particularly evident in Marutswa and Xotsheyake, where the forest edges were noticeably more open and less dense than forests unaffected by cattle grazing (pers. obs.).

These harvesting activities have been present in many Afrotemperate forests, which could result in fragmentation and alterations in vital ecosystem functions, with the forest structure and composition being altered by the cutting of poles and collection of firewood (Cooper and Moll 1968; Lawes et al. 2007a; Cooper et al. 2017). The heavy exploitation of many of the forests in Bulwer could be one of the reasons these forests had the lowest overall PSR (32), than Karkloof (42) and Dargle (36), as the harvesting of these resources, could potentially lead to the local extinction of certain tree species (Lawes et al. 2007a). The extraction of resources in the forests surveyed in the state-owned forests in Bulwer, except for Ingelebantwana, could also have resulted in these forests having, on average, the lowest stem density of trees between the 6-10 m (3.68) and 11-15 m (1.8) height categories, when compared with those privately-owned forests surveyed in Karkloof (6-10 m = 6.75; 11-15 m = 3.17) and Dargle (6-10 m = 4.25; 11-15 m = 4.19). Ingelebantwana did not show indications of resource extraction in the forest, with there being no nearby communities. Instead, the forest was surrounded by natural grassland and exotic plantations, which could explain the considerably higher average number of trees in these height categories.

3.5.2 Impact of microhabitat structure on bushbuck and Cape porcupine

When assessing the factors most influential to the presence of the two analysed mammalian species, it becomes apparent that there is considerable variation in the microhabitat variables influencing their presence between the wet and dry seasons. These microhabitat variables displayed variations not only between forest patches but between seasons as well, which were found independent of the occupancy modelling as well as in the raw data analysis. Bushbuck, which is a forest specialist, had the highest detection in the wet and dry seasons of all the mammalian species identified. Bushbuck were present in every forest surveyed in the wet season; however, bushbuck were not detected on the camera traps in two forests (Waterfall and Xotsheyake) during the dry season. Bushbuck showed a positive relationship with bare ground in the wet and dry seasons, with the bushbuck also being positively influenced by the presence of trees of varying lengths; however, there seemed to be a particular preference for the presence of short trees (2-5 m) and woody samplings (0-2 m). This is supported by the fact that bushbuck are browsers whose diet primarily consists of dicotyledonous plant forms (MacLeod et al. 1996; Venter and Kalule-Sabiti 2016; Bayih and Yihune 2018), with bushbuck further having a preference for more densely vegetated areas (MacLeod et al. 1996), with the plant species and vegetation structure being important factors determining food for the bushbuck (Coates and Downs 2006).

Microhabitat preferences did show some variations between the wet and dry seasons, with herbaceous cover positively influencing the detection probability of bushbuck in the wet season, whereas in the dry season, leaf litter was observed to be more influential. These findings are similar to those observed by Ehlers Smith et al. (2017), who found the preference of bushbuck to occupy those areas with higher percentage covers of saplings and woody species. Bushbuck were also found in the vast majority of sites during both seasons, regardless of the level of anthropogenic disturbances experienced, although these more disturbed areas (primarily the forests in Bulwer) did have considerably lower naïve occupancies of bushbuck, likely because of the hunting activities observed in these forests, than the forests in Karkloof and Dargle, which are privately-owned. The persistence of bushbuck is because of the flexibility of the species, allowing them to persist even in those environments which experienced significant anthropogenic disturbances, which could include dense urban areas and hunting pressures (Bayih and Yihune 2018).

Cape porcupines were present in almost every forest patch surveyed in the wet and dry seasons, except for Sharedown, Milestone, and Nxumeni in the wet season and Waterfall and Nxumeni in the dry season. Cape porcupine detections were considerably higher in the dry season (247) than in the wet season (106). This difference in Cape porcupine detections between seasons was contrary to our prediction that detections would be similar between seasons, with this result being possible because of several factors. This could include the fact that the feeding behaviour of Cape porcupines, being a generalist species, could be determined by the change in seasons, which results in an altering of their diet (Kraai et al. 2023). This is particularly evident in the dry seasons, whereby these herbivores would forage previously unwanted foods (Kraai et al. 2023). Another factor could pertain to the fact that Cape porcupines could use these forests as fire refugia during the dry season, whereby these minimally affected environments play a vital role in the survival of fire-sensitive species (Dornbusch et al. 2022). Although a generalist species which benefits from habitat transformations, they are still vulnerable to the threats of hunting and persecution (Ngcobo et al. 2019), which could explain the overall lower naïve occupancies of Cape porcupine in the state-owned forests in Bulwer.

Numerous microhabitat variables positively influenced Cape porcupine detection probability, particularly tree stem densities of varying sizes (SD2, SD6, SD11, SD16, SD25), for both seasons, with grass cover, leaf litter and plant species richness positively influencing their detection probability in the dry season. The broad range of microhabitat variables positively influencing the presence of Cape porcupines indicates their wide ecological tolerance (Van Aarde 1987; Ngcobo et al. 2019), with bare ground, canopy closure, stem density of trees 20-25 m and grass cover being the only variables negatively impacting their detection probability across both seasons. Being generalists, Cape porcupines have a wide diet range, primarily determined by the available resources (Ngcobo et al. 2019).

3.6 Conclusions

When examining the microhabitat structural differences between the wet and dry seasons, as well as between the state-owned and privately-owned forests, it becomes apparent that various microhabitat variables displayed significant variations. Between seasons, microhabitat variables, such as herbaceous cover and grass cover, were overall higher during the wet season, with leaf litter being considerably higher during the dry season, which supports our prediction. When assessing whether historical pressures could still be inferred based on the microhabitat conditions characterising the forest, this study found that the heavily logged privately-owned forests exhibited noticeably lower stem densities of trees higher than 20 m, with the less historically logged state-owned forests having higher canopy heights. The PSR was also observed to be, on average, lower in the privately-owned forests, which is likely because of the more significant edge effects experienced by the state-owned forests, which increase plant species diversities, particularly at the forest edge. Microhabitat variables played a significant role in forest mammalian occupancy and detection probability, particularly for bushbuck, in the Southern Mistbelt Forests in the Midlands of KwaZulu-Natal, South Africa. The microhabitat variables influencing the presence of these mammals varied between the wet and dry seasons. However, some microhabitat variables positively influenced their presence through both seasons, such as bare ground and short trees and saplings for bushbuck presence, which supported our initial prediction. Cape porcupines were positively influenced by a range of microhabitat variables, which is supported by their generalist nature, feeding on whichever resources are available. We found the observed overuse of forest resources and hunting practices in state-owned forests seemingly had a higher impact on these mammalian species' naïve occupancies. Our study also found that although many of the surveyed forests were formally protected, there were uncontrolled collections of forest resources by the local communities, particularly in some of the forests surveyed in Bulwer (pers. obs., unpublished data).

Although forest mammals display considerable resilience because of the climatic history of these forests and their naturally fragmented nature, these mammals are still vulnerable to the additional pressures exerted on them by anthropogenic activities. This was particularly evident in the state-owned forests in Bulwer, whereby the use of forest resources by the local people, coupled with hunting, was shown to decrease the naïve occupancies of both bushbuck and Cape porcupine, which went against our prediction that state-owned forests would have higher naïve occupancies of Cape porcupine, because of the edge effects these forests were likely to experience. Although the bushbuck is a highly resilient species, these practices also decreased their overall naïve occupancies compared with the privately-owned forests in the Karkloof and Dargle, indicating that the present pressures these forests face are more influential than the historical impacts. The microhabitat factors influencing the presence of Cape porcupine, and particularly bushbuck, as well as the impacts overuse of forest resources has on the persistence of these mammals, will contribute to the implementation of effective management decisions, which will ensure these relatively fragile environments are protected, creating suitable environments for forest mammalian species to persist.

3.7 Acknowledgements

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3.8 References

Abdi, H. (2003) *Factor Rotations in Factor Analyses*. Sage, California.

Abdi, H. & Williams, L.J. (2010) Principal component analysis. *Wiley Interdisciplinary Reviews: Computational Statistics*, **2**, 433-459.

Abiem, I., Arellano, G., Kenfack, D. & Chapman, H. (2020) Afromontane forest diversity and the role of grassland-forest transition in tree species distribution. *Diversity*, **12**, 30.

Adie, H., Kotze, D.J. & Lawes, M.J. (2017) Small fire refugia in the grassy matrix and the persistence of Afrotemperate Forest in the Drakensberg Mountains. *Scientific Reports*, **7**, 1-10.

Adie, H., Rushworth, I. & Lawes, M.J. (2013) Pervasive, long-lasting impact of historical logging on composition, diversity and above ground carbon stocks in Afrotemperate Forest. *Forest Ecology and Management*, **310**, 887–895.

Alin, A. (2010) Multicollinearity. *Wiley Interdisciplinary Reviews: Computational Statistics*, **2**, 370-374.

Arroyo-Rodríguez, V., Fahrig, L., Tabarelli, M., Watling, J.I., Tischendorf, L., Benchimol, M., Cazetta, E., Faria, D., Leal, I.R., Melo, F.P.L., Morante-Filho, J.C., Santos, B.A., Arasa-Gisbert, R., Arce-Pena, N., Cervantes-Lopez, M.J., Cudney-Valenzuela, S., Galán-Acedo, C., San-José, M., Vieira, I.C.G., Silk, J.W.F., Nowakowski, A.J. & Tscharntke, T. (2020) Designing optimal human-modified landscapes for forest biodiversity conservation. *Ecology Letters*, **23**, 1404-1420.

Bach, C.E. & Kelly, D. (2004) Effects of forest edges, fruit display size, and fruit colour on bird seed dispersal in a New Zealand mistletoe, *Alepis flavida*. *New Zealand Journal of Ecology*, **93**-103.

Bayih, W. & Yihune, M. (2018) Population status, feeding ecology and activity pattern of common bushbuck (*Tragelaphus Scriptus decula*) in Sekele Mariam Forest, West Gojjam, Ethiopia. *Journal of Ecology and the Natural Environment*, **10**, 69-79.

Beavers, A.S., Lounsbury, J.W., Richards, J.K., Huck, S.W., Skolits, G.J. & Esquivel, S.L. (2013) Practical considerations for using exploratory factor analysis in educational research. *Practical Assessment, Research, and Evaluation*, **18**, 6.

Benítez-Malvido, J. & Martínez-Ramos, M. (2003) Impact of forest fragmentation on understory plant species richness in Amazonia. *Conservation Biology*, **17**, 389-400.

Bibby, C., Burgess, N. & Hill, D. (2000) *Bird Census Techniques*. Academic Press, London.

Bitani, N., Cordier, C.P., Ehlers Smith, D.A., Ehlers Smith, Y.C. & Downs, C.T. (2023) Microhabitat requirements and occupancy of understorey bird forest specialists in Southern Mistbelt Forests of KwaZulu-Natal, South Africa. *Forest Ecology and Management*, **549**, 121484.

Buitenwerf, R., Swemmer, A.M. & Peel, M.J. (2011) Long-term dynamics of herbaceous vegetation structure and composition in two African savanna reserves. *Journal of Applied Ecology*, **48**, 238-246.

Carbutt, C. & Martindale, G. (2014) Temperate indigenous grassland gains in South Africa: lessons being learned in a developing country. *Parks*, **20**, 104-125.

Coates, G.D. & Downs, C.T. (2006) A preliminary study of valley thicket and coastal bushveld-grassland habitat use during summer by bushbuck (*Tragelaphus scriptus*): a telemetry based study. *South African Journal of Wildlife Research*, **36**, 167-172.

Cooper, K.H. & Moll, E.J. (1968) *Some Notes on an Area of the Karkloof Forest, Natal*. Wildlife Protection and Conservation Society, Natal Fieldwork Section, Durban.

Cooper, T.J., Wannenburgh, A.M. & Cherry, M.I. (2017) Atlas data indicate forest dependent bird species declines in South Africa. *Bird Conservation International*, **27**, 337–354.

Crouzeilles, R., Beyer, H.L., Mills, M., Grelle, C.E. & Possingham, H.P. (2015) Incorporating habitat availability into systematic planning for restoration: a species-specific approach for Atlantic forest mammals. *Diversity and Distributions*, **21**, 1027–1037.

Cunningham, A.B. (1991) Development of a conservation policy on commercially exploited medicinal plants: a case study from southern Africa. *Conservation of Medicinal Plants*, 337–358.

de Souza, F.M. & Batista, J.L.F. (2004) Restoration of seasonal semideciduous forests in Brazil: influence of age and restoration design on forest structure. *Forest Ecology and Management*, **191**, 185-200.

DiStefano, C., Zhu, M. & Mindrila, D. (2009) Understanding and using factor scores: considerations for the applied researcher. *Practical Assessment, Research, and Evaluation*, **14**, 20.

Dornbusch, M.J., Limb, R.F., Bloom-Cornelius, I.V., Elmore, R.D., Weir, J.R. & Fuhlendorf, S.D. (2022) Factors influencing the persistence of a fire-sensitive *Artemisia* species in a fire-dependent ecosystem. *Ecological Applications*, **32**, e2604.

Downs, C.T. & Symes, C.T. (2004) Snag dynamics and forest structure in Afromontane forests in KwaZulu-Natal, South Africa: implications for the conservation of cavity-nesting avifauna. *South African Journal of Botany*, **70**, 265-276.

Ehlers Smith, Y.C, Ehlers Smith, D.A, Ramesh, T. & Downs, C.T. (2017) The importance of microhabitat structure in maintaining forest mammal diversity in a mixed land-use mosaic. *Biodiversity and Conservation*, **26**, 2361-2382.

Everard, D.A. (1992) On the feasibility of developing a functional classification as a decision support system for the management of the indigenous forests in Natal. *Report FOR-DEA*, **458**, 1-30.

Fahrig, L. (2003) Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology, Evolution, and Systematics*, **34**, 487-515.

Fremout, T., Thomas, E., Gaisberger, H., Van Meerbeek, K., Muenchow, J., Briers, S., Gutierrez-Miranda, C.E., Marcelo-Peña, J.L., Kindt, R., Atkinson, R., Cabrera, O., Espinosa, C.I., Aguirre-Mendoza, Z. & Muys, B. (2020) Mapping tree species vulnerability to multiple threats as a guide to restoration and conservation of tropical dry forests. *Global Change Biology*, **26**, 3552–3568.

Geldenhuys, C.J. (1997) Native forest regeneration in pine and eucalypt plantations in Northern Province, South Africa. *Forest Ecology and Management*, **99**, 101-115.

Ghazoul, J., Burivalova, Z., Garcia-Ulloa, J. & King, L.A. (2015) Conceptualizing forest degradation. *Trends in Ecology & Evolution*, **30**, 622-632.

Gorsuch, R.L. (2013) Factor Analysis. In: Schinka, J.A. and Velicer, W.F (Eds.), *Research Methods in Psychology*. John Wiley & Sons, Inc, New York.

Grass, I., Loos, J., Baensch, S., Batáry, P., Librán-Embid, F., Ficiciyan, A., Klaus, F., Riechers, M., Rosa, J., Tiede, J., Udy, K., Westphal, C., Wurz, A. & Tscharntke, T. (2019) Land-sharing/-sparing connectivity landscapes for ecosystem services and biodiversity conservation. *People and Nature*, **1**, 262-272.

Grieve, G.R.H. & Downs, C.T. (2015) 'A checklist of the plants of the forests and grasslands in the Weza district, southern KwaZulu-Natal and a review of their status in the Red Data List'. *Koedoe*, **57**, 1-7.

Griffiths, M.E. & Lawes, M.J. (2006) Biogeographic, environmental, and phylogenetic influences on reproductive traits in subtropical forest trees, South Africa. *Ecography*, **29**, 614–622.

Gumede, N., Mutanga, O. & Sibanda, M. (2022) Mapping leaf area index of the Yellowwood tree species in an Afromontane mistbelt forest of southern Africa using topographic variables. *Remote Sensing Applications: Society and Environment*, **27**, 100778.

Hart, L., Grieve, G. & Downs, C.T. (2013) Fruiting phenology and implications of fruit availability in the fragmented Ingeli Forest Complex, KwaZulu-Natal, South Africa. *South African Journal of Botany*, **88**, 296-305. https://doi.org/10.1016/j.sajb.2013.08.003

Hill, J.L. & Curran, P.J. (2005) Fragment shape and tree species composition in tropical forests: a landscape level investigation. *African Journal of Ecology*, **43**, 35-43.

Hines, J.E. (2006) PRESENCE – Software to estimate patch occupancy and related parameters. *USGS-PWRC*. http://www.mbrwrc.usgs.gov/software/presence.html.

Illukpitiya, P. & Yanagida, J.F. (2010) Farming vs forests: Trade-off between agriculture and the extraction of non-timber forest products. *Ecological Economics*, **69**, 1952-1963.

King, N.L. (1941) The exploitation of the indigenous forests of South Africa. *Journal of the South African Forestry Association*, **6**, 26-48.

Kotze, D.J. & Lawes, M.J. (2007) Viability of ecological processes in small Afromontane forest patches in South Africa. *Austral Ecology*, **32**, 294-304.

Kotze, D.J. & Samways, M.J. (2001) No general edge effects for invertebrates at Afromontane forest/grassland ecotones. *Biodiversity & Conservation*, **10**, 443-466.

Kraai, U.M., Kraai, M., Tsvuura, Z., Mkhize, N.R. & Tjelele, T.J. (2023) The impacts of Cape porcupines on woody plant mortality. *Austral Ecology*, **00**, 1-10.

Laurance, W.F., Laurance, S.G., Ferreira, L.V., Rankin-de Merona, J.M., Gascon, C. & Lovejoy, T.E. (1997) Biomass collapse in Amazonian forest fragments. *Science*, **278**, 1117-1118.

Lavery, T.H., Posala, C.K., Tasker, E.M. & Fisher, D.O. (2020) Ecological generalism and resilience of tropical island mammals to logging: a 23 year test. *Global Change Biology*, **26**, 3285-3293.

Lawes, M.J. & Chapman, C.A. (2006) Does the herb *Acanthus pubescens* and/or elephants suppress tree regeneration in disturbed Afrotropical Forest? *Forest Ecology and Management*, **221**, 278–284.

Lawes, M.J., Eeley, H.A., Findlay, N.J. & Forbes, D. (2007b) Resilient forest faunal communities in South Africa: a legacy of palaeoclimatic change and extinction filtering? *Journal of Biogeography*, **34**, 1246–1264.

Lawes, M.J., Eeley, H.A. & Piper, S.E. (2000a) The relationship between local and regional diversity of indigenous forest fauna in KwaZulu-Natal Province, South Africa. *Biodiversity and Conservation*, **9**, 683-705.

Lawes, M.J., Joubert, R., Griffiths, M.E., Boudreau, S. & Chapman, C.A. (2007a) The effect of the spatial scale of recruitment on tree diversity in Afromontane forest fragments. *Biological Conservation*, **139**, 447-456.

Lawes, M.J., Kotze, D.J., Bourquin, S.L. & Morris, C. (2005b) Epigaeic Invertebrates as potential ecological indicators of Afromontane forest condition in South Africa. *Biotropica: The Journal of Biology and Conservation*, **37**, 109-118.

Lawes, M.J., Lamb, B.C.C. & Boudreau, S. (2005a) Area- but no edge-effect on woody seedling abundance and species richness in old Afromontane forest fragments. *Journal of Vegetation Science*, **16**, 363.

Lawes, M.J., MacFarlane, D.M. & Eeley, H.A. (2004) Forest landscape pattern in the KwaZulu-Natal midlands, South Africa: 50 years of change or stasis? *Austral Ecology*, **29**, 613–623.

Lawes, M.J., Mealin, P.E. & Piper, S.E. (2000b) Patch occupancy and potential metapopulation dynamics of three forest mammals in fragmented Afromontane forest in South Africa. *Conservation Biology*, **14**, 1088–1098.

MacKenzie, D.I., Nichols, J.D, Royle, J.A., Pollock, K.P., Bailey, L.L. & Hines, J.E. (2006) *Occupancy Estimation and Modeling: Inferring Patterns and Dynamics of Species Occurrence*. Academic Press, New York.

MacLeod, S.B., Kerley, G.I.H. & Gaylard, A. (1996) Habitat and diet of bush buck *Tragelaphus scriptus* in the Woody Cape Nature Reserve: observations from faecal analysis. *South African Journal of Wildlife Research*, **26**, 19-25.

Mensah, S., Egeru, A., Assogbadjo, A.E. & Glèlè Kakaï, R. (2020b) Vegetation structure, dominance patterns and height growth in an Afromontane forest, Southern Africa. *Journal of Forestry Research*, **31**, 453-462.

Mensah, S., Salako, K.V., Assogbadjo, A., Kakaï, R.G., Sinsin, B. & Seifert, T. (2020a) Functional trait diversity is a stronger predictor of multifunctionality than dominance: evidence from an Afromontane forest in South Africa. *Ecological Indicators*, **115**, 106415.

Moll, E.J. (1972) The current status of mistbelt mixed Podocarpus forest in Natal. *Bothalia*, **10**, 595-598.

Mucina, L., Geldenhuys, C.J. & Rutherford, M.C. (2006) Afrotemperate, subtropical and azonal forests. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia*, **19**, 584-614.

Murcia, C. (1996) Forest Fragmentation and the Pollination of Neotropical Plants. In: Schelhas, J. & Greenberg, R (Eds.), *Forest Patches in Tropical Landscapes*. Island Press, Washington, D.C.

Ngcobo, S.P., Wilson, A.L. & Downs, C.T. (2019) Habitat selection of Cape porcupines in a farmland-suburban context in KwaZulu-Natal, South Africa. *Mammalian Biology*, **98**, 111-118.

Qie, L., Telford, E.M., Massam, M.R., Tangki, H., Nilus, R., Hector, A. & Ewers, R.M. (2019) Drought cuts back regeneration in logged tropical forests. *Environmental Research Letters*, **14**, 045012.

Ramesh, T. & Downs, C.T. (2015) Impact of land use on occupancy and abundance of terrestrial mammals in the Drakensberg Midlands, South Africa. *Journal for Nature Conservation*, **23**, 9-18.

Richard, U., Byamungu, R.M., Magige, F. & Makonda, F.B. (2022) Microhabitat, altitude and seasonal influence on the abundance of non-volant small mammals in Mount Rungwe forest nature reserve. *Global Ecology and Conservation*, **35**, e02069.

Rodríguez-Echeverry, J., Fuentes, R., Leiton, M. & Jaque, E. (2018) Changing landscapes forest: implications for its conservation. *Environment and Natural Resources Research*, **8**, 44.

Skinner, J.D.J., Chimimba, C.T.C., 2005. *The Mammals of the Southern African Sub-region*. Cambridge University Press, Cambridge.

Sosibo, M., Ehlers Smith, Y., Ehlers Smith, D. & Downs, C.T. (2022) Some perspectives on the use and value of Southern Mistbelt Forests to surrounding rural communities in the in northern Eastern Cape, and southern KwaZulu-Natal, South Africa. *African Journal of Wildlife Research*, **52**,103–121. https://doi.org/10.3957/056.052.0103

Stoner, K.E. & Timm, R.M. (2011) Seasonally Dry Tropical Forest Mammals: Adaptations and Seasonal Patterns. In: Dirzo, R., Young, H.S., Mooney, H.A. and Ceballos, G (Eds.), *Seasonally Dry Tropical Forests*. Island Press, London.

Symes, C.T., Wirminghaus, J.O., Downs, C.T. (2002) Species richness and seasonality of forest avifauna in three South African Afromontane forests. *Ostrich*, **73**, 106–113.

Taylor, M.R. & Peacock, F. (2018) *State of South Africa's Bird Report 2018*. BirdLife South Africa, Johannesburg.

Tichý, L. (2016) Field test of canopy cover estimation by hemispherical photographs taken with a smartphone. *Journal of Vegetation Science*, **27**, 427-435.

Van Aarde, R.J. (1987) Reproduction in the Cape porcupine *Hystrix africaeaustralis*: an ecological perspective. *South African Journal of Science*, **83**, 605-607.

Venter, J.A. & Kalule-Sabiti, M.J. (2016) Diet composition of the large herbivores in Mkambati Nature Reserve, Eastern Cape, South Africa. *African Journal of Wildlife Research*, **46**, 49-56.

Verzani, J. (2011) *Getting Started with RStudio*. O'Reilly Media, Inc, Sebastopol.

Wethered, R. & Lawes, M.J. (2003) Matrix effects on bird assemblages in fragmented Afromontane forests in South Africa. *Biological Conservation*, **114**, 327–340.

Weyer, V.D., Granger, J.E., Hill, T.R., & O'Connor, T.G. (2015) Land transformation and its implication for biodiversity integrity and hydrological functioning from 1944 to 1999, Karkloof catchment, South Africa. *Bothalia-African Biodiversity & Conservation*, **45**, 1-13.

White, F. (1978) The Afromontane Region. In: Werger, M.J.A (Eds.), *Biogeography and Ecology of Southern Africa*. Springer, The Hague.

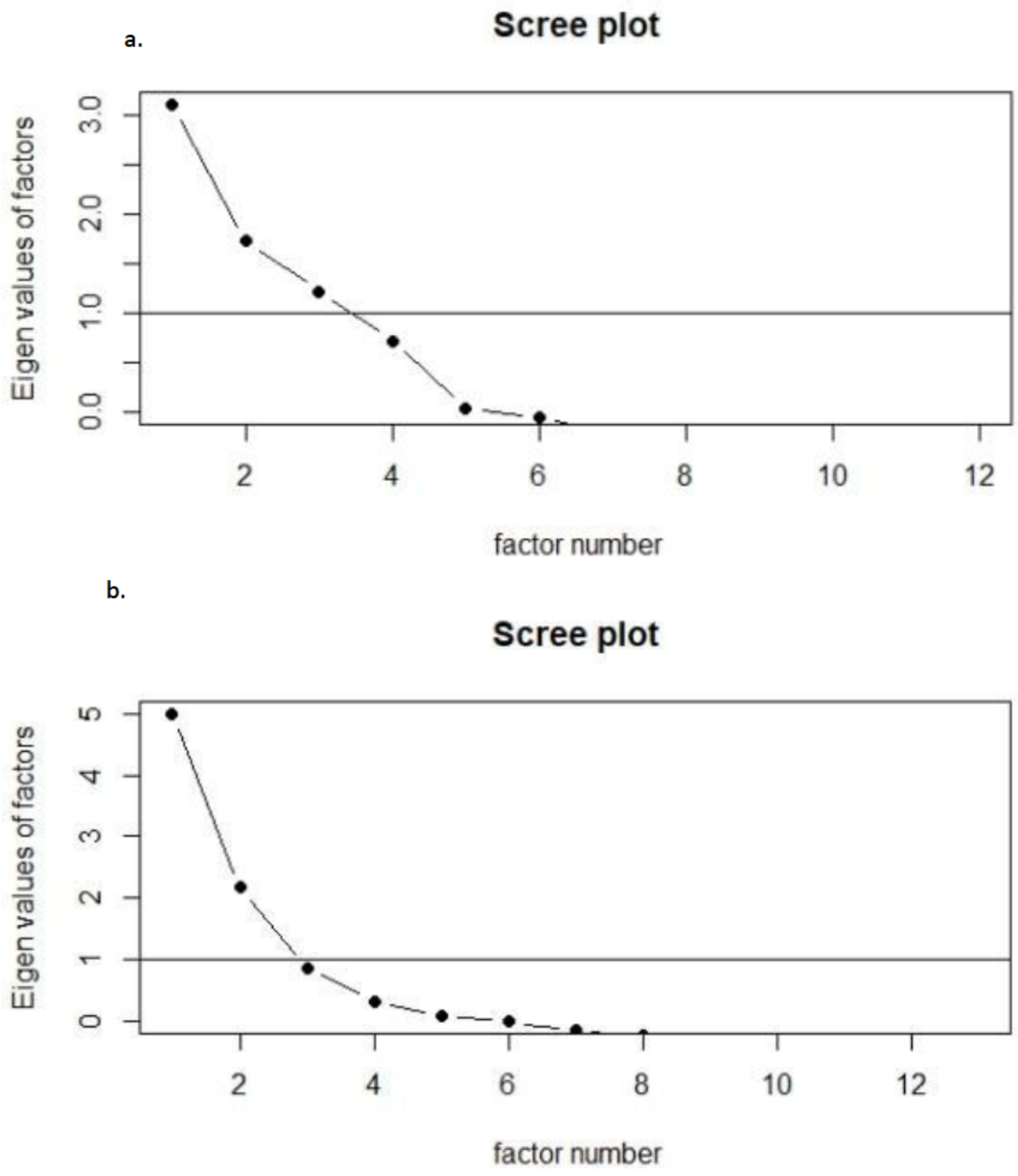
Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M. R. (1999) Conservation of the Cape parrot in southern Africa. *African Journal of Wildlife Research*, **29**, 118–128.

Wirminghaus, J.O. & Perrin, M.R. (1993) Seasonal changes in density, demography and body composition of small mammals in a southern temperate forest. *Journal of Zoology*, **229**, 303-318.

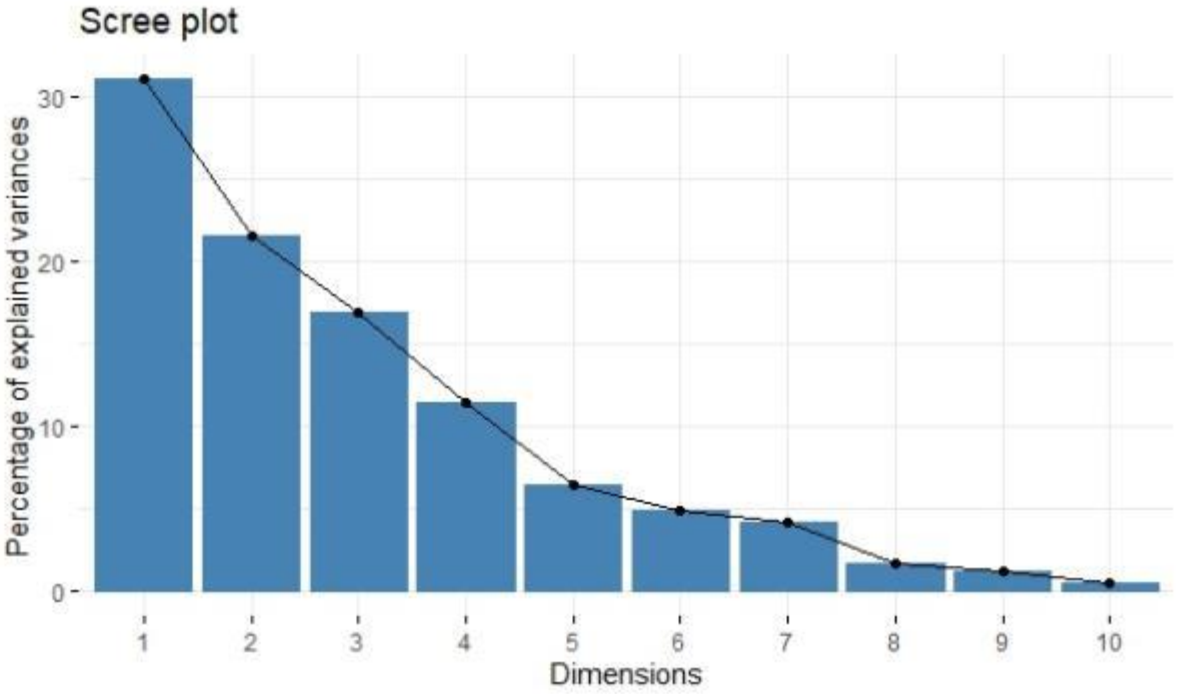
Yong, A.G. & Pearce, S. (2013) A beginner's guide to factor analysis: focusing on exploratory factor analysis. *Tutorials in Quantitative Methods for Psychology*, **9**, 79-94.

Zambrano, J., Garzon-Lopez, C.X., Yeager, L., Fortunel, C., Cordeiro, N.J. & Beckman, N. G. (2019) The effects of habitat loss and fragmentation on plant functional traits and functional diversity: what do we know so far? *Oecologia*, **191**, 505-518.

3.9 Supplementary Information

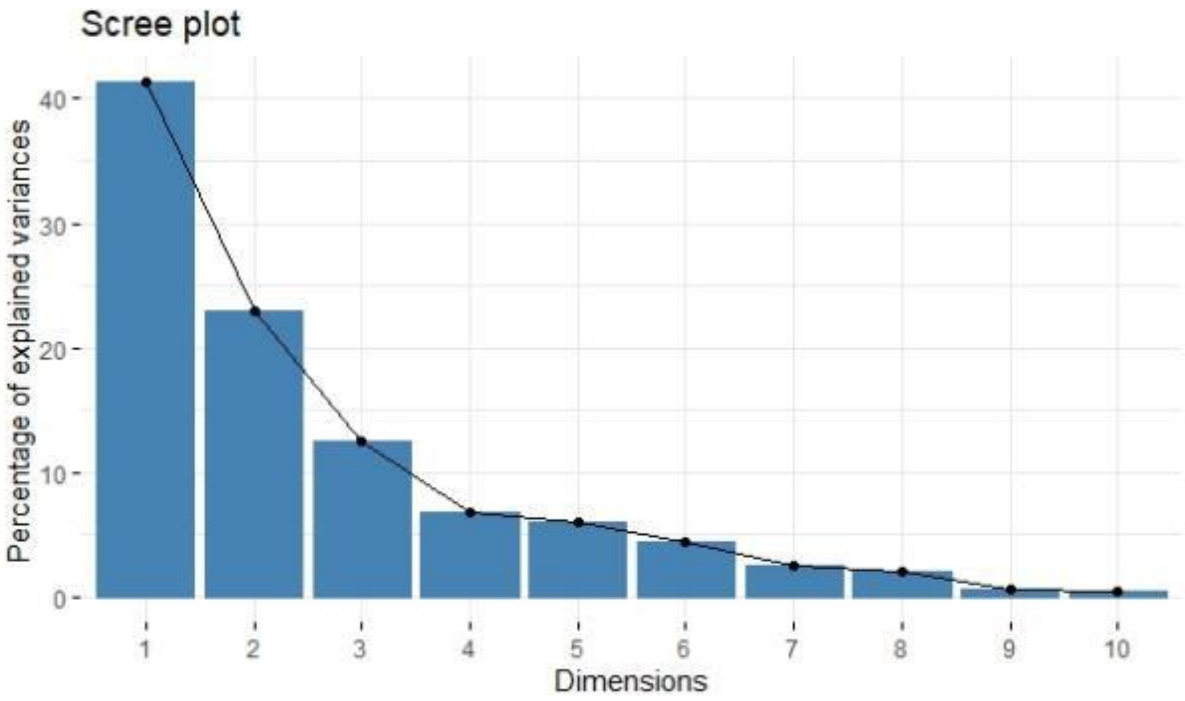


Supplementary Information Figure S3.1. Cattell's scree plot results for all forest patches in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa where a.) is the wet season, excluding the microhabitat variables: leaf litter, grass cover and heterogeneity index; b.) the dry season, excluding the microhabitat variables: stem density 16-20 m and heterogeneity index; and c.) both seasons, including all microhabitat variables.



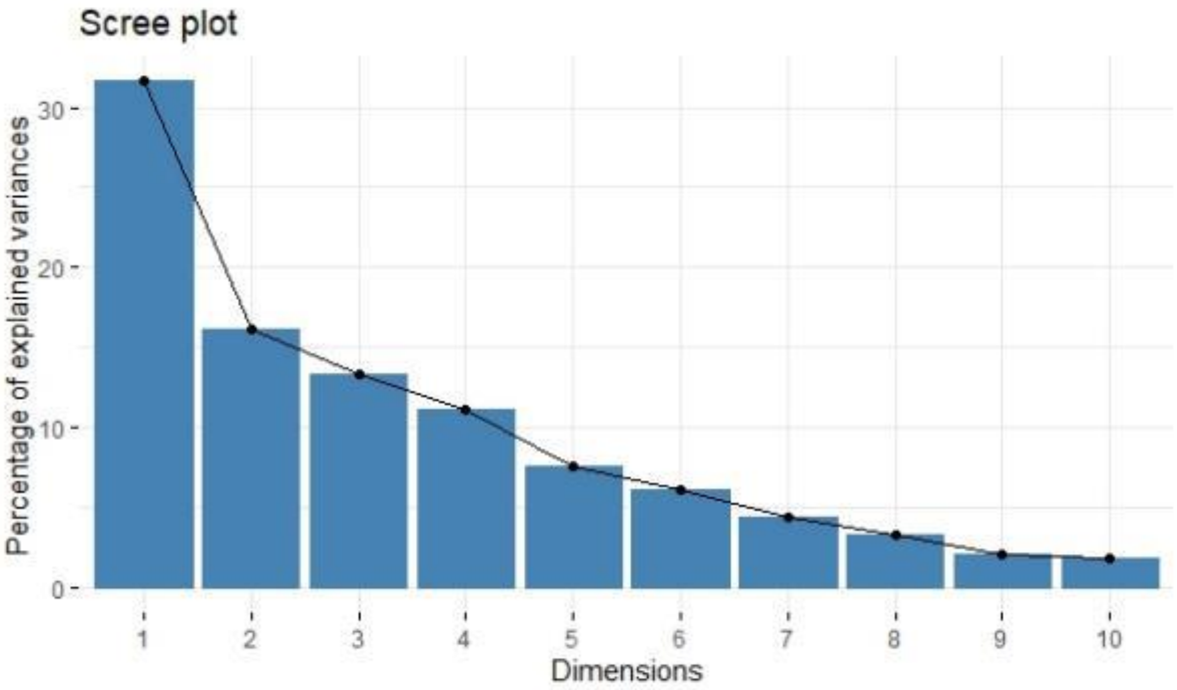
Importance of components:	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12
Standard deviation	1.93	1.61	1.43	1.17	0.87	0.77	0.70	0.44	0.36929	0.23709	0.19651	0.09031
Proportion of Variance	0.3104	0.22	0.17	0.11	0.06	0.05	0.04	0.02	0.01136	0.00468	0.00322	0.00068
Cumulative Proportion	0.3104	0.53	0.70	0.81	0.87	0.92	0.96	0.98	0.99142	0.9961	0.99932	1

Supplementary Information Figure S3.2a. Principal components plot and associated Table results displaying the percentage of total variance explained for each component for the wet season, excluding the microhabitat variables: leaf litter, grass cover and heterogeneity index, for all forest patches in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.



Importance of components:	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13
Standard deviation	2.32	1.73	1.27	0.94	0.89	0.76	0.57	0.52	0.29	0.26	0.16	0.08	0.05
Proportion of Variance	0.41	0.23	0.12	0.07	0.06	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00
Cumulative Proportion	0.43	0.64	0.77	0.83	0.90	0.94	0.97	0.99	0.99	1.00	1.00	1.00	1.00

Supplementary Information Figure S3.2b. Principal components plot and associated Table results displaying percentage of total variance explained for each component for the dry season, excluding the microhabitat variables: stem density 16-20 m and heterogeneity index, for all forest patches in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.



Importance of components:	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15
Standard deviation	2.18	1.56	1.41	1.29	1.06	0.96	0.82	0.70	0.56	0.53	0.41	0.30	0.27	0.19	0.06
Proportion of Variance	0.32	0.16	0.13	0.11	0.08	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.00
Cumulative Proportion	0.37	0.48	0.61	0.72	0.80	0.86	0.90	0.94	0.96	0.98	0.99	0.99	1.00	1.00	1.00

Supplementary Information Figure S3.2c. Principal components plot and associated Table results displaying percentage of total variance explained for each component for both seasons, including all microhabitat variables for all forest patches in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

Supplementary Information Table S3.1. Tree species found in the respective forest areas in the present study.

Tree species	Common name	Karkloof	Tree species	Common name	Dargle	Tree species	Common name	Bulwer
Gymosporia harveyana	Round-fruit forest spikethorn	**Karkloof**	*Gymosporia harveyana*	Round-fruit forest spikethorn	**Dargle**	*Gymosporia harveyana*	Round-fruit forest spikethorn	**Bulwer**
Carissa bispinosa	Forest num-num	**Karkloof**	*Carissa bispinosa*	Forest num-num	**Dargle**	*Carissa bispinosa*	Forest num-num	**Bulwer**
Solanum mauritianum	Bugweed	**Karkloof**	*Solanum mauritianum*	Bugweed	**Dargle**	*Solanum mauritianum*	Bugweed	**Bulwer**
Eugenia gerrardii	Forest umdoni	**Karkloof**	*Eugenia gerrardii*	Forest umdoni	**Dargle**	*Eugenia gerrardii*	Forest umdoni	**Bulwer**
Ptaeroxylon obliquum	Sneezewood	**Karkloof**	*Ptaeroxylon obliquum*	Sneezewood	**Dargle**	*Ptaeroxylon obliquum*	Sneezewood	**Bulwer**
Trimeria grandifolia	Wild mulberry	**Karkloof**	*Trimeria grandifolia*	Wild mulberry	**Dargle**	*Trimeria grandifolia*	Wild mulberry	**Bulwer**
Zanthoxylum capense	Small knobwood	**Karkloof**	*Zanthoxylum capense*	Small knobwood	**Dargle**	*Zanthoxylum capense*	Small knobwood	**Bulwer**
Xymalos monospora	Lemonwood	**Karkloof**	*Xymalos monospora*	Lemonwood	**Dargle**	*Xymalos monospora*	Lemonwood	**Bulwer**
Podorcapus latifolia	Real yellowwood	**Karkloof**	*Podorcapus latifolia*	Real yellowwood	**Dargle**	*Podorcapus latifolia*	Real yellowwood	**Bulwer**
Podocarpus falcatus	Common yellowwood	**Karkloof**	*Podocarpus falcatus*	Common yellowwood	**Dargle**	*Podocarpus falcatus*	Common yellowwood	**Bulwer**
Calodendrum capense	Cape chestnut	**Karkloof**	*Calodendrum capense*	Cape chestnut	**Dargle**	*Calodendrum capense*	Cape chestnut	**Bulwer**
Cassinopsis illicifolia	Lemon thorn	**Karkloof**	*Cassinopsis illicifolia*	Lemon thorn	**Dargle**	*Cassinopsis illicifolia*	Lemon thorn	**Bulwer**
Cryptocarya woodii	Cape quince	**Karkloof**	*Cryptocarya woodii*	Cape quince	**Dargle**	*Cryptocarya woodii*	Cape quince	**Bulwer**
Eugenia zuluensis	Paperbark Myrtle	**Karkloof**	*Eugenia zuluensis*	Paperbark myrtle	**Dargle**	*Eugenia zuluensis*	Paperbark Myrtle	**Bulwer**
Diospyros whyteana	Bladdernut	**Karkloof**	*Diospyros whyteana*	Bladdernut	**Dargle**	*Diospyros whyteana*	Bladdernut	**Bulwer**
Celtis africana	White skinkwood	**Karkloof**	*Celtis africana*	White stinkwood	**Dargle**	*Celtis africana*	White stinkwood	**Bulwer**
Tricalsia lanceolata	Jackal-coffee	**Karkloof**	*Cussonia sphaerocephala*	Forest cabbage tree	**Dargle**	*Cussonia sphaerocephala*	Forest cabbage tree	**Bulwer**
Cussonia sphaerocephala	Forest cabbage tree	**Karkloof**	*Elaeodendron croceum*	Common saffron	**Dargle**	*Elaeodendron croceum*	Common saffron	**Bulwer**
Elaeodendron croceum	Common saffron	**Karkloof**	*Calpurnia aurea*	common calpurnia	**Dargle**	*Calpurnia aurea*	Common calpurnia	**Bulwer**
Ilex mitis	Cape holly	**Karkloof**	*Salacia gerrardii*	Forest lemon-rope	**Dargle**	*Salacia gerrardii*	Forest lemon-rope	**Bulwer**
Calpurnia aurea	Common calpurnia	**Karkloof**	*Vepris lanceolata*	White ironwood	**Dargle**	*Vepris lanceolata*	White ironwood	**Bulwer**
Pyrostria hystrix	Porcupine-bush	**Karkloof**	*Podorcapus henkelii*	Drooping-leaf yellowwood	**Dargle**	*Podorcapus henkelii*	Drooping-leaf yellowwood	**Bulwer**
Solanum giganteum	Healing-leaf tree	**Karkloof**	*Clausena anisata*	Horsewood	**Dargle**	*Clausena anisata*	Horsewood	**Bulwer**
Salacia gerrardii	Forest lemon-rope	**Karkloof**	*Kiggelaria africana*	Wild peach	**Dargle**	*Kiggelaria africana*	Wild peach	**Bulwer**
Vepris lanceolata	White ironwood	**Karkloof**	*Ochna arborea*	Cold-bark ochna	**Dargle**	*Ochna arborea*	Cold-bark ochna	**Bulwer**
Podocarpus henkelii	Drooping-leaf yellowwood	**Karkloof**	*Rapanea melanophloes*	Cape beech	**Dargle**	*Rapanea melanophloes*	Cape beech	**Bulwer**
Clausena anisata	Horsewood	**Karkloof**	*Ficus craterostoma*	Forest fig	**Dargle**	*Ficus craterostoma*	Forest fig	**Bulwer**

Kiggelaria africana	Wild peach	**Karkloof**	*Casspourea malosana*	Common onionwood	**Dargle**	*Scolopia zeyheri*	Thorn pear	**Bulwer**
Ochna arborea	Cold-bark ochna	**Karkloof**	*Scolopia zeyheri*	Thorn pear	**Dargle**	*Halleria lucida*	Tree fuschia	**Bulwer**
Rapanea melanophloes	Cape beech	**Karkloof**	*Scutia myrtina*	Cat thorn	**Dargle**	*Zanthoxylum dayvi*	Forest knobwood	**Bulwer**
Ficus craterostoma	Forest fig	**Karkloof**	*Halleria lucida*	Tree fuschia	**Dargle**	*Drypetes gerrardii*	Forest ironplum	**Bulwer**
Casspourea malosana	Common onionwood	**Karkloof**	*Zanthoxylum dayvi*	Forest knobwood	**Dargle**	*Pittosporum viridiflorum*	Cheesewood	**Bulwer**
Cnestis poyphylla	Itch-pod	**Karkloof**	*Drypetes gerrardii*	Forest ironplum	**Dargle**			
Scolopia zeyheri	Thorn pear	**Karkloof**	*Scolopia mundii*	Red pear	**Dargle**			
Scutia myrtina	Cat thorn	**Karkloof**	*Pittosporum viridiflorum*	Cheesewood	**Dargle**			
Halleria lucida	Tree fuschia	**Karkloof**	*Peddiea africana*	Poison olive	**Dargle**			
Combretum edwardsii	Forest climbing bushwillow	**Karkloof**						
Zanthoxylum dayvi	Forest knobwood	**Karkloof**						
Drypetes gerrardii	Forest ironplum	**Karkloof**						
Pittosporum viridiflorum	Cheesewood	**Karkloof**						
Dovyalis rhamnoides	Sourberry Kei-apple	**Karkloof**						
Nuxia floribunda	Forest nuxia	**Karkloof**						

Supplementary Information Table S3.2. Total list of tree species found in the forests in the present study. (Note: E = exotic invasive)

Tree species	Common name
Gymosporia harveyana	Round-fruit forest spikethorn
Carissa bispinosa	Forest num-num
Solanum mauritianum	Bugweed^{E}
Eugenia gerrardii	Forest umdoni
Ptaeroxylon obliquum	Sneezewood
Trimeria grandifolia	Wild mulberry
Zanthoxylum capense	Small knobwood
Xymalos monospora	Lemonwood
Podorcapus latifolia	Real yellowwood
Podorcapus falcatus	Common yellowwood
Calodendrum capense	Cape chestnut
Cassinopsis illicifolia	Lemon thorn
Cryptocarya woodii	Cape quince
Eugenia zuluensis	Paperbark myrtle
Diospyros whyteana	Bladdernut
Celtis africana	White stinkwood
Tricalsia lanceolata	Jackal-coffee
Cussonia sphaerocephala	Forest cabbage tree
Elaeodendron croceum	Common saffron
Ilex mitis	Cape holly
Calpurnia aurea	Common calpurnia
Pyrostria hystrix	Porcupine-bush
Solanum giganteum	Healing-leaf tree
Salacia gerrardii	Forest Lemon-rope
Vepris lanceolata	White Ironwood
Podocarpus henkelii	Drooping-leaf yellowwood
Clausena anisata	Horsewood
Kiggelaria africana	Wild peach
Ochna arborea	Cold-bark ochna
Rapanea melanophloes	Cape beech
Ficus craterostoma	Forest fig
Casspourea malosana	Common onionwood
Cnestis poyphylla	Itch-pod
Scolopia zeyheri	Thorn pear
Scutia myrtina	Cat thorn
Halleria lucida	Tree fuschia
Combretum edwardsii	Forest climbing bushwillow
Zanthoxylum dayvi	Forest knobwood
Drypetes gerrardii	Forest ironplum
Pittosporum viridiflorum	Cheesewood
Dovyalis rhamnoides	Sourberry kei-apple
Nuxia floribunda	Forest nuxia
Scolopia mundii	Red pear
Peddiea africana	Poison olive

Supplementary Information Table S3.3a. Tree species found in forest patches in the Karkloof forest area in the present study. (Abbreviations: KNR = Karkloof Nature Reserve).

Tree species	Common name	Site			
Gymosporia harveyana	Round-fruit forest spikethorn	Benvie	Labri	KNR	Mbona
Carissa bispinosa	Forest num-num	Benvie	Labri	KNR	Mbona
Solanum mauritianum	Bugweed	Benvie	Labri	KNR	Mbona
Eugenia gerrardii	Forest umdoni	Benvie	Labri	KNR	Mbona
Ptaeroxylon obliquum	Sneezewood	Benvie	Labri	KNR	Mbona
Trimeria grandifolia	Wild mulberry	Benvie	Labri	KNR	Mbona
Zanthoxylum capense	Small knobwood	Benvie		KNR	Mbona
Xymalos monospora	Lemonwood	Benvie	Labri	KNR	Mbona
Podocarpus latifolia	Real yellowwood	Benvie	Labri	KNR	Mbona
Afrocarpus falcatus	Common yellowwood	Benvie	Labri	KNR	Mbona
Calodendrum capense	Cape chestnut	Benvie	Labri	KNR	Mbona
Cassinopsis illicifolia	Lemon thorn	Benvie	Labri	KNR	Mbona
Cryptocarya woodii	Cape quince	Benvie	Labri	KNR	Mbona
Eugenia zuluensis	Paperbark myrtle	Benvie	Labri	KNR	Mbona
Diospyros whyteana	Bladdernut	Benvie	Labri	KNR	Mbona
Celtis africana	White stinkwood	Benvie	Labri	KNR	Mbona
Tricalsia lanceolata	Jackal-coffee	Benvie			Mbona
Cussonia sphaerocephala	Forest cabbage tree	Benvie	Labri		Mbona
Elaeodendron croceum	Common saffron	Benvie	Labri	KNR	Mbona
Ilex mitis	Cape holly	Benvie		KNR	Mbona
Calpurnia aurea	Common calpurnia	Benvie	Labri	KNR	Mbona
Pyrostria hystrix	Porcupine-bush	Benvie	Labri	KNR	Mbona
Solanum giganteum	Healing-leaf tree	Benvie		KNR	Mbona
Salacia gerrardii	Forest lemon-rope	Benvie	Labri	KNR	Mbona
Vepris lanceolata	White ironwood		Labri	KNR	Mbona
Podorcapus henkelii	Drooping-leaf yellowwood		Labri	KNR	Mbona
Clausena anisata	Horsewood		Labri	KNR	Mbona
Kiggelaria africana	Wild peach		Labri	KNR	Mbona
Ochna arborea	Cold-bark ochna	Benvie	Labri	KNR	Mbona
Rapanea melanophloes	Cape beech		Labri	KNR	Mbona
Ficus craterostoma	Forest fig		Labri	KNR	Mbona
Casspourea malosana	Common onionwood		Labri		Mbona
Cnestis poyphylla	Itch-pod		Labri	KNR	Mbona
Scolopia zeyheri	Thorn pear			KNR	
Scutia myrtina	Cat thorn			KNR	Mbona
Halleria lucida	Tree fuschia			KNR	Mbona
Combretum edwardsii	Forest climbing bushwillow				Mbona
Zanthoxylum dayvi	Forest knobwood			KNR	
Drypetes gerrardii	Forest ironplum				Mbona
Pittosporum viridiflorum	Cheesewood			KNR	
Dovyalis rhamnoides	Sourberry kei-apple			KNR	
Nuxia floribunda	Forest nuxia				Mbona

Supplementary Information Table S3.3b. Tree species found in forest patches in the Dargle forest area in the present study. (Abbreviations: WF = Wakefield, SN = Sharedown, WL = Waterfall, ME = Milestone, RN = Rameron, MZ = Maritzdaal).

Tree species	**Common name**	**Site**					
Gymosporia harveyana	Round-fruit forest spikethorn	WF	SN	WL	ME	RN	MZ
Carissa bispinosa	Forest num-num	WF	SN	WL	ME	RN	MZ
Solanum mauritianum	Bugweed	WF			ME	RN	MZ
Eugenia gerrardii	Forest umdoni	WF	SN	WL	ME	RN	MZ
Ptaeroxylon obliquum	Sneezewood	WF	SN		ME	RN	MZ
Trimeria grandifolia	Wild mulberry	WF	SN	WL	ME	RN	
Zanthoxylum capense	Small knobwood	WF					MZ
Xymalos monospora	Lemonwood	WF			ME	RN	MZ
Podocarpus latifolia	Real yellowwood	WF	SN	WL	ME	RN	MZ
Afrocarpus falcatus	Common yellowwood	WF		WL	ME	RN	MZ
Calodendrum capense	Cape chestnut	WF			ME	RN	MZ
Cassinopsis illicifolia	Lemon thorn					RN	MZ
Cryptocarya woodii	Cape quince			WL	ME	RN	MZ
Eugenia zuluensis	Paperbark myrtle	WF	SN	WL	ME	RN	MZ
Diospyros whyteana	Bladdernut	WF	SN		ME	RN	MZ
Celtis africana	White stinkwood	WF	SN			RN	MZ
Cussonia sphaerocephala	Forest cabbage tree						MZ
Elaeodendron croceum	Common saffron					RN	MZ
Calpurnia aurea	Common calpurnia						MZ
Salacia gerrardii	Forest lemon-rope	WF					MZ
Vepris lanceolata	White ironwood	WF					MZ
Podocarpus henkelii	Drooping-leaf yellowwood				ME	RN	MZ
Clausena anisata	Horsewood						MZ
Kiggelaria africana	Wild peach	WF			ME	RN	MZ
Ochna arborea	Cold-bark ochna	WF					MZ
Rapanea melanophloes	Cape beech	WF			ME	RN	MZ
Ficus craterostoma	Forest fig				ME	RN	MZ
Casspourea malosana	Common onionwood						MZ
Scolopia zeyheri	Thorn pear	WF			ME		MZ
Scutia myrtina	Cat thorn				ME	RN	MZ
Halleria lucida	Tree fuschia	WF	SN		ME	RN	MZ
Zanthoxylum dayvi	Forest knobwood					RN	MZ
Drypetes gerrardii	Forest ironplum	WF			ME	RN	MZ
Scolopia mundii	Red pear						
Pittosporum viridiflorum	Cheesewood						MZ
Peddiea africana	Poison olive				ME		

Supplementary Information Table S3.3c. Tree species found in forest patches in the Bulwer forest area in the present study. (Abbreviations: MA = Marutswa, XT = Xotsheyake, IN = Ingelebantwana, NX = Nxumeni).

Tree species	**Common name**	**Site**			
Gymosporia harveyana	Round-fruit forest spikethorn	MA	XT	IN	NX
Carissa bispinosa	Forest num-num	MA	XT	IN	NX
Solanum mauritianum	Bugweed	MA	XT	IN	NX
Eugenia gerrardii	Forest umdoni	MA	XT	IN	NX
Ptaeroxylon obliquum	Sneezewood	MA	XT	IN	NX
Trimeria grandifolia	Wild mulberry	MA	XT	IN	NX
Zanthoxylum capense	Small knobwood	MA	XT	IN	NX
Xymalos monospora	Lemonwood	MA	XT	IN	NX
Podocarpus latifolia	Real yellowwood		XT	IN	NX
Afrocarpus falcatus	Common yellowwood	MA	XT	IN	NX
Calodendrum capense	Cape chestnut	MA			NX
Cassinopsis illicifolia	Lemon thorn	MA	XT		NX
Cryptocarya woodii	Cape quince	MA	XT	IN	NX
Eugenia zuluensis	Paperbark myrtle	MA	XT	IN	NX
Diospyros whyteana	Bladdernut	MA	XT	IN	NX
Celtis africana	White stinkwood	MA	XT		
Cussonia sphaerocephala	Forest cabbage tree	MA	XT		NX
Elaeodendron croceum	Common saffron			IN	NX
Calpurnia aurea	Common calpurnia	MA	XT	IN	NX
Salacia gerrardii	Forest lemon-rope	MA	XT	IN	
Vepris lanceolata	White Ironwood	MA	XT	IN	NX
Podorcapus henkelii	Drooping-leaf yellowwood	MA	XT	IN	NX
Clausena anisata	Horsewood	MA	XT	IN	NX
Kiggelaria africana	Wild peach	MA	XT	IN	NX
Ochna arborea	Cold-bark ochna			IN	
Rapanea melanophloes	Cape beech	MA	XT	IN	NX
Ficus craterostoma	Forest fig	MA		IN	NX
Scolopia zeyheri	Thorn pear			IN	
Halleria lucida	Tree fuschia	MA	XT	IN	
Zanthoxylum dayvi	Forest knobwood	MA			NX
Drypetes gerrardii	Forest ironplum	MA	XT	IN	NX
Pittosporum viridiflorum	Cheesewood			IN	

Supplementary Information Table S3.4. Factor analysis table results displaying factor scores for each microhabitat variable for all forest patches in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa for a.) the wet season, excluding: leaf litter, grass cover and heterogeneity index, b.) the dry season, excluding stem density 16-20 m and heterogeneity index; and c.) for both seasons. (See Table 3.1 for abbreviations).

a.

	Factor 1	Factor 2	Factor 3
BG	-0.076	-0.83	-0.565
HC	0.515	-0.168	0.21
W0	0.368	-0.15	-0.329
WA	0.583	-0.462	0.254
SD2	0.073	0.71	0.066
SD6	0.316	-0.001	0.991
SD11	-0.249	0.029	0.751
SD16	0.691	0.172	0.141
SD20	0.954	0.425	-0.05
SD25	0.657	-0.086	-0.049
PSR	0.319	0.776	-0.344
CC	-0.341	0.377	-0.071

b.

	Factor 1	Factor 2
BG	0	0.77
LL	-0.93	-0.24
GC	0.96	-0.45
HC	0.77	0.48
W0	-0.69	0.42
WA	0.12	0.67
SD2	-0.65	-0.04
SD6	0.83	0.06
SD11	0.6	0.24
SD20	0.1	0.49
SD25	-0.04	0.76
PSR	0.61	0.25
CC	0.39	-0.38

c.

	Factor 1	Factor 2	Factor 3
HI	0.65	0.27	0.08
BG	0.26	-0.54	0.13
LL	-1.03	0.06	0.49
GC	0.44	0.22	-0.98
HC	0.97	-0.02	0.05
W0	-0.40	-0.65	0.19
WA	0.40	-0.28	0.26
SD2	-0.02	0.16	0.00
SD6	0.44	0.45	0.35
SD11	0.14	0.81	0.51
SD16	0.70	0.05	-0.18
SD20	0.57	-0.22	-0.11
SD25	0.53	-0.35	0.16
PSR	0.06	-0.06	-0.43
CC	-0.13	0.32	-0.12

Supplementary Information Table S3.5. Detection histories for bushbuck and Cape porcupine between privately-owned and state-owned forests between the dry and wet seasons.

Number of times recorded in camera traps

Common name	Karkloof (wet)	Bulwer (wet)	Dargle (wet)	State-owned (wet)	Privately-owned (wet)	Total (wet)	Karkloof (dry)	Bulwer (dry)	Dargle (dry)	State-owned (dry)	Privately-owned (dry)	Total (dry)
Bushbuck	296	52	168	52	464	516	325	66	219	66	544	610
Cape porcupine	51	22	33	22	84	106	137	26	84	26	221	247

Number of camera traps with species records

	Karkloof (wet)	Bulwer (wet)	Dargle (wet)	State-owned (wet)	Privately-owned (wet)	Total (wet)	Karkloof (dry)	Bulwer (dry)	Dargle (dry)	State-owned (dry)	Privately-owned (dry)	Total (dry)
Bushbuck	76	25	39	25	115	140	80	23	34	23	114	137
Cape porcupine	21	9	10	9	31	40	43	15	22	15	65	80

Percentage of sites with species detection (%)

	Karkloof (wet)	Bulwer (wet)	Dargle (wet)	State-owned (wet)	Privately-owned (wet)	Karkloof (dry)	Bulwer (dry)	Dargle (dry)	State-owned (dry)	Privately-owned (dry)
Bushbuck	87.4	71.4	92.9	71.4	89.2	85.1	56.1	85.0	56.1	85.1
Cape porcupine	24.1	25.7	23.8	25.7	24.0	45.7	36.6	55.0	36.6	48.5

Supplementary Information Table S3.6. Naïve occupancy of bushbuck and Cape porcupine during the wet and dry seasons between the three forest clusters and between state-owned and privately-owned forests.

Forest cluster	**Naïve occupancy of bushbuck wet season**	**Naïve occupancy of bushbuck dry season**	**Naïve occupancy of Cape porcupine wet season**	**Naïve occupancy of Cape porcupine dry season**
Karkloof	0.87	0.85	0.24	0.46
Bulwer	0.71	0.56	0.26	0.37
Dargle	0.93	0.85	0.24	0.55
State-owned	0.71	0.56	0.26	0.37
Privately-owned	0.90	0.85	0.24	0.50

Supplementary Information Table S3.7. Naïve occupancy of bushbuck and Cape porcupine in each forest patch during the wet and dry season.

Forest patch	**Naïve occupancy of bushbuck wet season**	**Naïve occupancy of bushbuck dry season**	**Naïve occupancy of Cape porcupine wet season**	**Naïve occupancy of Cape porcupine dry season**
Mbona	0.83	0.78	0.08	0.41
Benvie	0.88	1.00	0.63	0.63
Karkloof Nature Reserve	0.87	0.84	0.27	0.47
L'Abri	1.00	1.00	0.20	0.40
Marutswa	0.55	0.64	0.36	0.73
Xotsheyake	0.75	0.00	0.50	0.75
Ingelebantwana	0.89	0.67	0.33	0.33
Nxumeni	0.73	0.57	0.00	0.00
Wakefield	1.00	0.75	0.25	0.50
Maritzdaal	0.86	0.95	0.19	0.53
Rameron	1.00	0.75	0.50	0.75
Milestone	1.00	1.00	0.00	0.50
Sharedown	1.00	1.00	0.00	0.50
Waterfall	N/A	0.00	N/A	0.00
Total naïve occupancy	0.85	0.78	0.24	0.46

Supplementary Information Table S3.8. Beta values and their corresponding standard errors for the microhabitat variables in top performing occupancy models of bushbuck and Cape porcupine during the wet and dry season.

Bushbuck (wet season)	**Microhabitat variables**	**Estimate**	**std. error**
Probability of occupancy (psi)	Heterogeneity Index	0.58	0.00
	Bare ground (%)	-1.53	0.00
	Stem density trees 2-5 m	-0.61	0.00
	Water (%)	1.56	0.00
Detection probability (P)	Herbaceous cover (%)	-0.16	0.00
	Water (%)	0.10	0.00
	Canopy closure	-0.00	0.00
	Stem density trees 2-5 m	0.12	0.00
	Stem density trees >25 m	-0.14	0.00
	Heterogeneity Index	0.08	0.00
Bushbuck (dry season)			
Probability of occupancy (psi)	Sapling and short woody plants 0-2 m (%)	-0.36	0.18
	Stem density trees >25 m	-2.12	740.81
	Bare ground (%)	-0.30	0.17
Detection probability (P)	Canopy closure	-0.19	0.05
	Stem density trees 16-20 m	0.14	0.07
	Grass cover (%)	-0.13	0.06
	Stem density trees >25 m	0.14	-1.#IND00
	Bare ground (%)	-0.13	0.06
	Stem density trees 20-25 m	-0.10	0.06
	Plant species richness	-0.11	0.05
	Heterogeneity Index	0.07	0.07
	Leaf litter (%)	0.11	0.06
	Stem density trees 2-5 m	-0.08	0.05
	Stem density trees 6-10 m	0.08	0.05
Cape porcupine (wet season)			
Probability of occupancy (psi)	Stem density trees 11-15 m	-0.37	0.00
	Plant species richness	0.37	0.00
Detection probability (P)	Water (%)	0.60	0.00
	Stem density trees 11-15 m	-0.53	0.00
	Stem density trees 16-20 m	0.47	0.00
	Sapling and short woody plants 0-2 m (%)	0.35	0.00
	Stem density trees 2-5 m	-0.38	0.00
	Stem density trees 6-10 m	-0.39	0.00
	Heterogeneity Index	-0.26	0.00
	Stem density trees >25 m	0.14	0.00
Cape porcupine (dry season)			
Probability of occupancy (psi)	Stem density trees 2-5 m	0.19	0.17
	Canopy closure	0.34	0.18

Detection probability (P)	Leaf litter (%)	0.45	0.10
	Stem density trees 6-10 m	0.26	0.10
	Grass cover (%)	0.30	0.10
	Water (%)	0.23	0.08
	Stem density trees 11-15 m	0.11	0.07
	Plant species richness	-0.13	0.09

CHAPTER 4

Effect of seasonality and landscape factors on the occupancy of mammalian species within the Southern Mistbelt Forests of KwaZulu-Natal, South Africa

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Running header: Occupancy of forest mammals

4.1 Abstract

Afromontane forests of KwaZulu-Natal Province, South Africa, are highly fragmented, both naturally and anthropogenically, significantly impacting the biodiversity therein. This makes implementing effective conservation management strategies to conserve the biodiversity in these forests challenging. We investigated the presence of mammalian forest species in the Southern Mistbelt Forests in the Midlands of KwaZulu-Natal in 2020-2021, and how these occupancies differed between patches and seasons. We also investigated the influence of patch size, landscape configuration (number of neighbouring patches) and patch isolation (distance from mainland patch) on forest mammalian species diversities. We deployed a total of 339 camera traps across 14 selected indigenous forest patches of varying sizes across three different study areas in the Midlands. We installed camera traps using a systematic grid placement of 400 m x 400 m, with the camera traps being active for 24 h for at least 21 days. Camera trap locations were sampled in the wet (October – April) and dry (May – September) seasons to determine the difference in forest mammal presence across both seasons. We found that mammalian species richness was higher during the dry season, likely because of generalist species, such as Cape porcupine *Hystrix africaeaustralis* and bushpig *Potamochoerus larvatus*, using forest resources when they are otherwise scarce, with these forests also potentially been used as refugia from fire. Mammalian species richness was higher in the larger forest patches and, generally, those patches with higher landscape configurations. Isolation distance did not seem to be particularly impactful on species richness in these forests, likely because of the nature of the surrounding matrix, with the use of the surrounding patches acting as ‘stepping stones’ for these mammals. This reinforces the need for conservation measures to be more focused on these smaller patches as they are of high conservation value.

Keywords Camera traps, Occupancy modelling, Forest mammals

4.2 Introduction

Biodiversity loss worldwide is primarily the result of habitat loss, fragmentation and increased population growth (Aben et al. 2014; 2016; Alexander et al. 2019). This is particularly evident in Africa, which has one of the world's highest human population growth rates, putting substantial pressure on natural environments and their resources (Amar and Cloete 2018). Loss of habitat often results in isolated fragments of natural environments, with the local extinctions of certain species occurring because of the lack of required environmental conditions, with species having varying tolerance levels to fragmentation (Bell and Donnelly 2006; Aben et al. 2014; Zungu et al. 2019).

In forested landscapes, fragmentation results in the division of a continuous forest into several smaller isolated patches (Liu et al. 2019), resulting in overall patch size reduction and an increase in isolation distances (Fahrig 2003). This can impact many species, such as their persistence and distribution, with the ecological interactions between species being impacted as well (Magrach et al. 2014). Due to this, the effects of fragmentation differ between species, with species more reliant on these ecological interactions being more severely affected (Magrach et al. 2014; Banks-Leite et al. 2020). The extinction of species in forest fragments is difficult to prevent, with certain species being certainly lost; however, with the adoption of appropriate management strategies, some species can persist in these fragmented landscapes (Murcia 1996; Grass et al. 2019; Arroyo-Rodríguez et al. 2020).

MacArthur and Wilson’s (1967) island biogeography theory (IBT) has been applied to habitat fragmentation as an analogy, whereby habitat fragments are seen as oceanic islands being surrounded by a harsh matrix (Bueno and Peres 2019), which could be in the form of agricultural land, or general modified land-use (Fox and Fox 2000). The IBT considers that species diversities are determined by the processes of immigration and extinction, with immigration rates decreasing with increasing isolation, with extinction rates decreasing with larger island areas (Wu and Vankat 1995; Helmus et al. 2014). Due to the higher diversity of habitat types in larger patches, there is more speciation, with smaller habitats having a higher degree of closely related species and, therefore, less habitat variety because of lower colonisation rates, resulting in lower species richness (Fox and Fox 2000; Helmus et al. 2014; Ehlers Smith et al. 2020). Various factors, such as patch size, dispersal capability, mobility and the habitat matrix surrounding a patch, will impact the number of species disappearing in fragmented forest patches (Ehlers Smith et al. 2020).

Mammals play several roles in ecosystems, which include the modification of vegetation structures, consuming and dispersing of seeds, being predators or prey and increasing nutrient cycling (Sinclair 2003; Ehlers Smith et al. 2020; Oblerosler et al. 2020; Beca et al. 2022). These factors result in species composition changes, with large mammals, in particular, impacting biodiversity and ecosystem functioning (Sinclair 2003). Mammals, such as the bushpig *Potamochoerus larvatus* and common duiker *Cephalophus grimmia*, have the ability to affect tree distributions in forests, as they remove fruits under parent trees, with some of these fruits being taken to other areas (Sinclair 2003). Mammals which disturb the soil surface layer in search of food, water and shelter, increase water infiltration, soil moisture and organic matter content of the soil, with these activities often resulting in improved soil health and seedling recruitment (Beca et al. 2022).

Alterations in mammalian community richness and structures could have various negative effects, including an ecosystem's stability (Oblerosler et al. 2020). Due to the importance forest mammals play in plant-animal relations, particularly as seed dispersers, their removal could severely impact ecosystem functioning, thereby reducing the stability of the ecosystem (Grande-Vega et al. 2016; Hegerl et al. 2017). Forest mammals face many threats that could reduce their populations, including fragmentation and forest loss resulting from anthropogenic land use (McAlpine et al. 2006). Forest-dependent mammalian species are particularly at risk because of these factors, as they have very particular habitat requirements and cannot move through the land use matrix (McAlpine et al. 2006). Hunting of forest mammals is considered to be one of the biggest threats these mammals face, particularly in Africa, with the meat of wild animals being a staple diet of many forest-dwelling people, with bushmeat further contributing to considerable incomes for many people (Fa and Brown 2009; Ripple et al. 2016; Hegerl et al. 2017). The demand for bushmeat has risen significantly with the increase in human population, with the hunting pressures resulting in the vulnerability of many wildlife species, particularly the larger mammal species with slower growth and reproduction rates, to local extinction (Fa and Brown 2009; Grande-Vega et al. 2016; Ripple et al. 2016; Hegerl et al. 2017).

To monitor biodiversity, the use of remotely-triggered camera traps has been a popular research tool for collecting species abundance or density data using a non-invasive method (Mann et al., 2015; Brassine and Parker 2015; Anile and Devillard 2016). The density estimations obtained through camera traps are essential for the establishment or evaluation of effective conservation management strategies, as they provide valuable information on the status of species, including those rare species occurring at low densities (Brassine and Parker 2015; Balestrieri et al. 2016; Chauvenet et al. 2017). The use of camera traps allows for the sampling of multiple species in an environment, with valuable information such as the time and location of each capture provided, which can be used to compare the spatial and/or temporal patterns for various species (Ridout and Linkie 2009; Cusack et al. 2017).

Camera traps are an effective method for inventorying cryptic species across different landscape types using a non-invasive, reliable and cost-effective method (Treves et al. 2010; Ramesh and Downs 2013; Swinnen et al. 2014; Dorning and Harris 2019). Camera traps are particularly useful in those environments which hinder the ability to directly observe wildlife, such as those environments characterised by dense vegetation, such as forests, which would make animal signs extremely difficult to find, or to observe wildlife in nocturnal conditions (Giman et al. 2007; Treves et al. 2010). This is particularly beneficial when attempting to identify the seasonal variations in forest mammal occupancy, whereby seasonal change will alter the microhabitat conditions within forests, with forest mammals, particularly the forest specialist mammals, having to alter their preferred habitats within forests to obtain their necessary dietary requirements, or migrate out of them (Stoner and Timm 2011; Richard et al. 2022). Forest generalist species, however, can alter their diet based on the available food resources (Stoner and Timm 2011).

In Africa, forests occupy approximately 21% of land cover, with these forests accounting for roughly 14% of the global forest area (Kelatwang and Garzuglia 2006; Xiao et al. 2022). The rapid rate at which these forests were converted to agricultural land meant that many forest species relied on disturbed forest patches for a chance of survival, as these disturbances would reduce the overall habitat availability for species (Lawes and Chapman 2006; Kadoya et al. 2022). In South Africa, forests are the smallest biome, comprising roughly 0.6% of the land surface area and occur primarily along the southern and eastern coastline (Lawes et al. 2007; Adie et al. 2013; Mangwale et al. 2017). The three main types of forests in the country include the Indian Ocean Coastal Belt Forest, the Afrotemperate Forests, which occur inland, and Scarp Forests, which run perpendicular between the Afrotemperate and Coastal Forests along river gorges (Mucina and Rutherford 2006; Lawes et al. 2007).

Forests in KwaZulu-Natal Province, South Africa, are highly rich in fauna and flora diversities (Ricketts and Shackleton 2020); however, they are a challenge to conserve because of their predominantly small patch size and highly fragmented distribution, often being difficult to access (Adie et al. 2013). The large forest patches are vital as they are population sources for both mammals and birds, with the conservation of these forests and their surrounding areas being necessary for these diversities to exist (Iezzi et al. 2018). In those highly fragmented forest regions, it may be beneficial to implement an alternative conservation strategy, which could aid in reducing the effects introduced through landscape fragmentation, with the formation of a network of protected areas being a likely measure to conserve biodiversity (Diniz et al. 2018). To maintain ecosystem function, as well as manage land-use practices, biodiversity assessments are an essential element of conservation planning (Chapman et al. 2018).

The Southern Mistbelt Forests in the KwaZulu-Natal Midlands are naturally fragmented because of the significant climate changes experienced during the Quaternary period (Wethered and Lawes 2003; Griffiths and Lawes 2006). Anthropogenic pressures have worsened the fragmentation of these forests, particularly because of the logging activities during the period between 1870 – 1944 by the colonial settlers, causing the Karkloof and Balgowan forests to be ~40 % of their initial coverage, with the expanse of agriculture and plantations also contributing significantly to the fragmentation of these forests (Lawes et al. 2000, 2004; Wethered and Lawes 2003; Adie et al. 2013). Since then, commercial logging activities have ceased; however, the increased frequency of fires, and harvesting of fuelwood, food, building materials and medicinal plants by local communities have increased the pressures exerted on these forests (Lawes et al. 2004; Cooper et al. 2017). These anthropogenic disturbances are expected to affect the presence of some species, with forest-dependent species expected to decrease, whilst non-forest dependent species are expected to use the forest resources (Symes et al. 2002). In these Afromontane forests, hunting is a factor influencing the presence of some forest mammal species, especially those occurring in isolated islands, with low population numbers and small geographic ranges, such as the blue duiker *Philantomba monticola* (Grande-Vega et al. 2016). These anthropogenic disturbances have resulted in many of these forest patches no longer being surrounded by natural grassland, which have instead been replaced by alien vegetation and exotic tree plantations (Wethered and Lawes 2003;

Lawes et al. 2004; Taylor and Peacock 2018). Despite these transformations, fire-maintained grasslands, consisting primarily of *Themeda triandra,* are still prevalent across the majority of the Afromontane region (White 1978). Forest area in the Midlands of KwaZulu-Natal has not changed considerably since the 1940s (Lawes et al. 2004), which has given forest mammalian communities sufficient time to respond to these historical anthropogenic disturbances (Lawes et al. 2000).

Using camera traps, we aimed to determine the forest mammalian species richness to several factors, including patch size, forest patch isolation and landscape configuration in the naturally fragmented Southern Mistbelt Forests in the KwaZulu-Natal Midlands, South Africa. We further assessed whether the austral wet and dry seasons would impact the forest mammal species diversities in these forests. We predicted that larger patch sizes, and forests surrounded by a higher number of forest patches would result in higher species richness, whereas increased isolation distances from the mainland forest patches would result in lower species diversities. This follows the IBT, which assumes that the larger and less isolated islands would have higher species richness (Fahrig 2013; Helmus et al. 2014). We further predicted that forest mammalian species diversities of forests would be higher during the wet season because of abundant resources.

4.3 Methods

4.3.1 Study area

Our study was conducted in the indigenous Southern Mistbelt Forest patches in the KwaZulu-Natal Midlands, located between Karkloof (29°18'1.98" S, 30°20'25.66" E), located ~22 km North of Howick, and Bulwer (29°48' 28.54" S, 29°45' 32.79" E; Figure 4.1.), located ~38 km East of Underberg, in south-western KwaZulu-Natal. These forests are found at elevations between ~1000 and 1500 m a.s.l., with the Karkloof forest being one of the largest

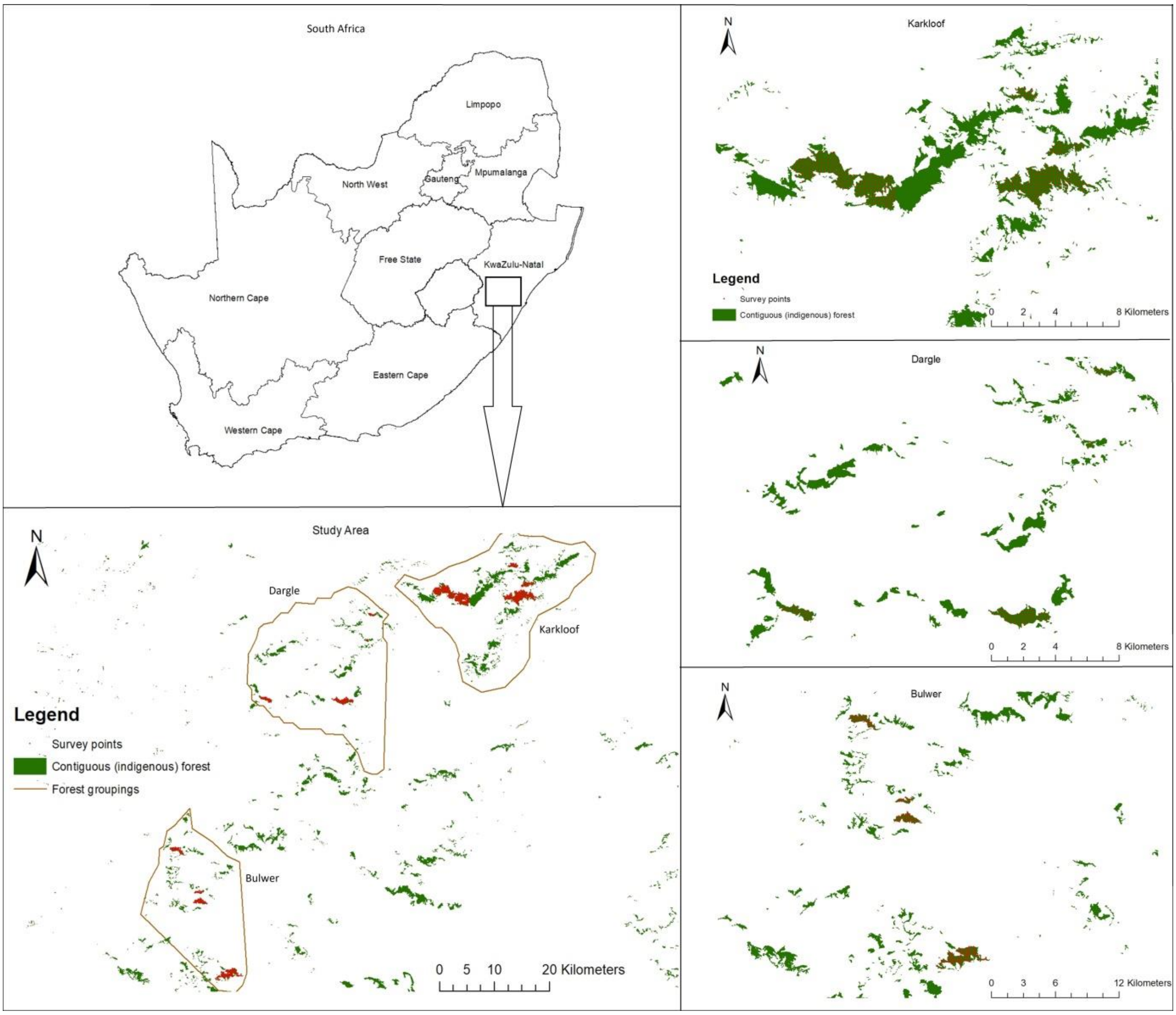

Figure 4.1: Study area, showing the locations of the camera trap surveys within the selected patches of Southern Mistbelt Forests between Karkloof (29°18'1.98" S, 30°20'25.66" E) and Bulwer (29°48' 28.54" S, 29°45' 32.79" E) in the Midlands of KwaZulu-Natal, South Africa.

Afromontane forests in KwaZulu-Natal (Wirminghaus and Perrin 1993; Lawes et al. 2005; Mucina et al. 2006), with the Karkloof Nature Reserve alone being ~1710 ha. These forests receive ~1600 mm of rain annually, which mainly occurs during the summer months, with temperatures ranging considerably from -4 - 37 °C, with the forests occurring on south-facing slopes (Symes et al. 2002; Lawes et al. 2005). These forests usually have a canopy height ranging from roughly 15-20 m (Wethered and Lawes 2003; Lawes et al. 2005; Mucina et al.

2006), with some of the highest canopy trees reaching heights of ~37 m (White 1978). This region's forests generally comprise ~60 tree species (Lawes et al. 2005). However, the tree species in this region are highly uniform, which could be practically defined using 12 tree species (White 1978).

4.3.2 Survey site selection

We located indigenous forest patches using the 2018 land cover map and the geographic information system (GIS) software ArcGIS version 10.7 (ESRI, Redlands, CA, USA). Indigenous forest patches larger than 0.5 ha were extracted, all of which were classified as Southern Mistbelt Forest (Mucina et al. 2006). Forests were categorised according to the study regions: Karkloof, Dargle and Bulwer, with forest patches of varying sizes being selected within each study area. In each study area, at least one mainland patch was selected, which was at least 200 ha, with surrounding patches being selected based on their size and distance from a mainland patch. This resulted in 14 indigenous forest patches being selected for this study, ranging from <50 – 1710 ha. Forest patch size categories followed that provided by Wirminghaus et al. (1999), in which class A = <50 ha, B = 51 – 100 ha, C = 101 – 500 ha, D = 501 – 1000 ha, E = >1000 ha.

4.3.3 Camera trap surveys

Camera trap locations were selected by creating a 400 m x 400 m grid over the indigenous forest layer in GIS, with a global positioning system (GPS) coordinate being extracted at every grid intersection located within the selected forest patch. The extracted coordinates were then imported into a GPS (Garmin eTrex® 20x, Garmin International, Olathe, USA) to be located in the field. Not all GPS coordinates were accessible in the field for camera traps to be installed, so we got as close to these points as possible. Nevertheless, we maintained a minimum distance of 400 m between camera traps. To monitor the presence of forest mammals at each survey site, one of four models of infrared motion detection camera traps (Moultrie M-880 8 MP; M-888i 14 MP, Moultrie Feeders, Birmingham, AL, USA; Cuddeback E3 20 MP, Greenbay, WI, USA; Browning Strike Force Apex 18 MP, Morgan, UT, USA) were installed at each GPS coordinate, with ~65 camera traps being deployed at a time. Forests were surveyed twice, first between October 2020 – April 2021 (wet season), and between May 2021 – September 2021 (dry season). Installation procedures for the camera traps followed those by Ehlers Smith et al. (2017a), whereby installed camera traps were left to operate in the field for at least 21 days, with camera traps being operational 24 h/day. At each survey location, a camera trap was attached to a sturdy tree, with the camera trap being placed ~30 cm above the ground. The camera trap was directed towards the area where forest mammals were most likely to be present (animal trails, gaps in vegetation, etc.), with the camera trap facing the area, allowing for the largest coverage of the motion detect sensor (Ehlers Smith et al. 2017a). Any vegetation which could obstruct the camera trap, or result in the constant triggering of the camera, was removed. The camera traps were set to motion detect, with the highest passive infrared sensitivity, with a trigger delay of 30 s, with each trigger capturing a single image at the highest quality allowed by the camera. Trigger speeds were left at the camera's default setting, which differed based on the make of camera trap used (Moultrie M-880, 1 sec; Moultrie-M888i, <0.7 sec; Cuddeback E3, 0.25 sec; Browning Strike Force Apex, 0.22 sec). This study did not use bait or attractants.

4.3.4 Forest fragmentation characteristics

To assess the impact forest patch connectivity and isolation distance from the mainland patch had on forest mammal species diversity, we used the 2018 land cover map in ArcGIS version 10.7 (ESRI, Redlands, CA, USA). Here, we calculated forest patch size with forest patch connectivity being calculated based on the number of forest patches in an 800 m buffer around each surveyed forest patch. This buffer was incorporated based on the approximate dispersal distance of the blue duiker, which was identified as the most specialised forest mammalian species in our study area (Lawes et al. 2000; Ehlers Smith et al. 2020). Forest patch isolation distances were calculated as the straight-line distance of the surveyed forest patch from the nearest mainland patch, which was at least 200 ha. Surveyed forest patches identified as being mainland patches, and hence had an isolation distance of 0 m, included: Karkloof Nature Reserve (1710 ha; Table 4.1), Mbona (679 ha), L'Abri (199 ha), Nxumeni (406 ha) and Maritzdaal (237 ha). L'Abri was considered a mainland patch as it was only slightly less than the designated 200 ha.

4.3.5 Data analyses

From the camera trap images, a forest mammalian species presence/absence was recorded for each forest patch surveyed. The detection histories for each identified mammalian species were recorded for 21 days using a binary detection history (1 = present, 0 = absent). Due to the difficulty in identifying certain detections at the species level, these detections were categorised at the genus or order level to prevent misidentifications. These detections were classified as African climbing mice *Dendromus* spp. and hyrax Hyracoidea. Detection histories for the wet and dry seasons were analysed independently.

From these detection histories, we calculated forest mammalian species richness and naïve occupancies per patch and cluster (Karkloof, Bulwer, Dargle) during the wet and dry seasons, with domestic mammals excluded from these totals. We then compared the factors of season, forest patch size, connectivity, and isolation distance to these identified forest mammalian species diversities to identify the factors potentially influencing them.

Table 4.1 Sampling effort and location of each forest patch across the surveyed Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa. Forests are classified according to Wirminghaus et al. (1999) size classes: A = <50 ha, B = 51 – 100 ha, C = 101 – 500 ha, D = 501 – 1000 ha, E = >1000 ha.

Area	**Forest patch**	**Coordinates**	**Size (ha)**	**Size class**	**Number of functional cameras out of the total number installed**	
					Wet season	**Dry season**
Karkloof	Mbona Private Nature Reserve	29°18’08” S; 30°22’26” E	679	D	24 (28)	27 (28)
	Benvie Forest	29°15’27” S; 30°21’29” E	93	B	8 (8)	8 (8)
	Karkloof Nature Reserve	29°17’50” S; 30°13’59” E	1710	E	45 (51)	49 (51)
	L'Abri Forest	29°17’08” S; 30°23’40” E	199	C	10 (10)	10 (10)
Bulwer	Marutswa Forest	29°48’36” S; 29°47’25” E	139	C	11 (11)	11 (11)
	Xotsheyake Forest	29°47’46” S; 29°47’16” E	57	B	4 (5)	4 (5)
	Ingelebantwana Forest	29°43’43” S; 29°44’35” E	148	C	9 (13)	12 (13)
	Nxumeni Forest	29°55’38” S; 29°50’42” E	406	C	11 (14)	14 (14)
Dargle	Wakefield Forest	29°28’57” S; 29°53’44” E	111	C	8 (9)	8 (9)
	Maritzdaal Forest	29°29’06” S; 30°02’57” E	237	C	21 (21)	19 (21)
	Rameron Forest	29°20’34” S; 30°05’43” E	96	B	8 (8)	8 (8)
	Milestone Forest	29°22’57” S; 30°05’40” E	53	B	3 (3)	2 (3)
	Sharedown Forest	29°29’06” S; 29°54’28” E	<50	A	2 (2)	2 (2)
	Waterfall Forest	29°30’54” S; 29°54’18” E	<50	A	0 (1)	1 (1)
					Total = 164/184	**Total = 175/184**

4.4 Results

Due to camera trap malfunctions and theft, 164 out of the 184 installed camera trap stations were included for the wet season, with one forest patch containing a single camera trap (Waterfall) being excluded due to camera malfunction, resulting in 13 forest patches being included in the wet season, with 175 out of the 184 installed camera trap stations being included in the dry season, resulting in a total of 339 camera trap stations in this study (Table 4.1). Karkloof had a total of 181 camera trap locations (wet season = 87; dry season = 94) across four forest patches, Dargle had 82 camera trap locations (wet season = 42; dry season = 40) across six forest patches, and Bulwer received the remaining 76 camera trap locations (wet season = 35; dry season = 41) across four forest patches (Table 4.1). The Karkloof Nature Reserve had the largest forest patch size (1710 ha), followed by Mbona (679 ha), whereas the Sharedown and Waterfall (<50 ha) had the smallest forest patch size (Table 4.1). The forests in Karkloof had the highest average patch size (670.25 ha), followed by Bulwer (187.5 ha) and Dargle (~99.5 ha) (Table 4.1).

Including camera malfunction and theft, 3215 trap days were conducted in the wet season, with the dry season having 3551 trap days, resulting in a total sampling effort of 6766 trap days across both seasons. This yielded 20 mammalian species in the wet season and 22 species in the dry season, with both seasons resulting in a total of 23 forest mammalian species being identified (Table 4.2), which included domestic animals (cattle *Bos taurus*, dog *Canis lupus familiaris*, and goat *Capra aegagrus hircus*) and humans *Homo sapiens*. The mean site species richness was 7.08 in wet and 8.57 in dry seasons. The most frequently captured species in the wet and dry seasons were bushbuck *Tragelaphus sylvaticus* (16.7%) and Cape porcupine *Hystrix africaeaustralis* (5.2%, Table 4.2).

Once we removed domestic mammals and humans, mammalian species richness totalled 19 across both seasons (Supplementary Information Table S4.1). During the wet season, the Karkloof and Dargle forests had the highest mammalian species richness of 12, Bulwer had the lowest species richness of nine, while the average patch mammalian species richness was 5.54 (Table 4.3). Mbona had the highest mammalian species richness (n = 10) out of all the forest patches surveyed, with L'Abri and Milestone having the lowest (n = 2).

Table 4.2 Mammalian species identified along with the number of times captured in the camera traps and the number of cameras recording their presence in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

		Number of times recorded in camera traps		**Number of camera traps with species records**	
Common name	**Scientific name**	**Wet**	**Dry**	**Wet**	**Dry**
African climbing mice	*Dendromus* spp.	5	17	1	4
Black-backed jackal	*Canis mesomelas*	11	32	7	12
Blue duiker	*Philantomba monticola*	45	23	12	13
Bushbuck	*Tragelaphus sylvaticus*	521	610	144	137
Bushpig	*Potamochoerus larvatus*	43	78	31	51
Cape clawless otter	*Aonyx capensis*	0	2	0	2
Cape porcupine	*Hystrix africaeaustralis*	107	247	41	80
Caracal	*Caracal caracal*	11	22	10	16
Chacma baboon	*Papio ursinus*	8	31	5	9
Common duiker	*Sylvicapra grimmia*	2	5	2	2
Domestic cattle	*Bos taurus*	9	49	5	19
Domestic dog	*Canis lupus familiaris*	35	62	19	30
Domestic goat	*Capra aegagrus hircus*	1	3	1	1
Greater cane rat	*Thryonomys swinderianus*	1	0	1	0
Human	*Homo sapiens*	81	73	36	21
Large grey mongoose	*Herpestes ichneumon*	0	1	0	1
Hyrax	Hyracoidea spp.	2	2	1	2
Samango monkey	*Cercopithecus albogularis*	33	33	23	24
Serval	*Leptailurus serval*	0	2	0	2
Slender mongoose	*Galerella sanguinea*	2	14	2	10
South African large-spotted genet	*Genetta tigrina*	20	70	14	30
Vervet monkey	*Chlorocebus pygerythrus*	5	4	5	4
Water mongoose	*Atilax paludinosus*	2	2	2	2

During the dry season, the forest mammalian species richness was fairly even between the three study areas (Karkloof (14), Bulwer (15), and Dargle (15)), with the Karkloof Nature Reserve having the highest species richness of 11, whilst no species were recorded at Waterfall, with average patch species richness being 7.00 (Table 4.4). When comparing forest mammalian species richness between seasons (Figure 4.2), the dry season exhibited generally higher species richness than the wet season, particularly in Benvie, L'Abri, Ingelebantwana and Nxumeni (see Table 4.1 for locations and forest sizes). Of the 14 surveyed forest patches, only two patches showed a higher species richness during the wet season (Mbona and Rameron; see Table 4.1 for locations and forest sizes).

Forest mammalian species richness was generally higher in the larger forest patches during both seasons (Figure 4.3), with the largest patches (Karkloof Nature Reserve, Mbona, Nxumeni and Maritzdaal) generally having a considerably higher forest mammalian species richness compared with the smaller forest patches (Sharedown, Milestone and Xotsheyake). Some larger forest patches (L'Abri and Nxumeni) showed low species richness during the wet season; however, during the dry season, species richness increased significantly. The remaining forest patches displayed slight species richness differences between seasons.

Bushbuck presence was captured at all of the forest patches during the wet season (13; Table 4.3), with Cape porcupine (10/13) and bushpig (9/13) occurring in the majority of the sampled forest patches as well. Non-domestic mammalian species only recorded at one forest patch during the wet season included: African climbing mice (Rameron), cane rat *Thryonomys swinderianus* (Mbona), common duiker *Sylvicapra grimmia* (Maritzdaal) and hyrax (Ingelebantwana). During the dry season, bushbuck, bushpig and Cape porcupine occurred in most forest patches (12/14; Table 4.4). Large grey mongoose was the only non-domestic mammalian species found at a single site (Rameron).

Table 4.3 Mammalian species found in each forest patch and cluster (highlighted) during the wet season in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

Species found in the wet season	**Karkloof**	Benvie	L'Abri	KNR	Mbona	**Dargle**	Wakefield	Sharedown	Milestone	Rameron	Maritzdaal	**Bulwer**	Marutswa	Xotsheyake	Ingelebantwana	Nxumeni	**No. of sites found**
African climbing mice						✓				✓							1
Black-backed Jackal	✓			✓		✓	✓				✓	✓	✓	✓			5
Blue duiker	✓			✓	✓							✓				✓	3
Bushbuck	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	13
Bushpig	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓		✓	✓	9
Cane rat	✓				✓												1
Cape porcupine	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		10
Caracal	✓			✓	✓	✓	✓				✓	✓	✓				5
Chacma baboon						✓	✓				✓	✓			✓		3
Common duiker						✓					✓						1
Domestic cattle	✓				✓	✓	✓					✓		✓		✓	4
Domestic dog	✓			✓		✓					✓	✓	✓		✓	✓	5
Domestic goat												✓		✓			1
Human	✓		✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	10
Hyrax												✓			✓		1
Samango monkey	✓			✓	✓	✓	✓	✓		✓	✓						6
Slender mongoose	✓				✓	✓				✓							2
South African large-spotted genet	✓			✓	✓	✓				✓	✓	✓			✓	✓	6
Vervet monkey	✓	✓				✓		✓	✓	✓							4
Water mongoose	✓			✓	✓												2
Total species	15	4	3	11	11	15	9	4	2	9	11	13	7	6	8	7	
Excluding domestic mammals and humans	12	4	2	9	10	12	7	3	2	8	9	9	5	3	6	4	

Table 4.4 Mammalian species found in each forest patch and cluster (highlighted) during the dry season in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

Species found in the dry season	**Karkloof**	Benvie	L'Abri	KNR	Mbona	**Dargle**	Wakefield	Sharedown	Waterfall	Milestone	Rameron	Maritzdaal	**Bulwer**	Marutswa	Xotsheyake	Ingelebantwana	Nxumeni	**No. of sites found**
African climbing mice						✓						✓	✓				✓	2
Black-backed Jackal	✓	✓	✓	✓		✓	✓				✓	✓	✓	✓		✓		8
Blue duiker	✓	✓		✓		✓					✓		✓				✓	4
Bushbuck	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	12
Bushpig	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	12
Cape clawless otter						✓	✓						✓			✓		2
Cape porcupine	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		12
Caracal	✓	✓		✓	✓	✓	✓			✓		✓	✓				✓	7
Chacma baboon						✓	✓					✓	✓			✓		3
Common duiker	✓				✓	✓						✓						2
Domestic cattle	✓				✓								✓	✓	✓	✓	✓	5
Domestic dog	✓		✓	✓	✓	✓						✓	✓	✓	✓	✓	✓	8
Domestic goat													✓		✓			1
Human	✓			✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	8
Large grey mongoose						✓					✓							1
Hyrax	✓			✓									✓	✓				2
Samango monkey	✓		✓	✓	✓	✓	✓	✓				✓	✓				✓	7
Serval	✓	✓				✓	✓											2
Slender mongoose	✓	✓	✓	✓	✓	✓						✓	✓			✓		6
South African large-spotted genet	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓	✓	✓	10
Vervet monkey	✓			✓									✓		✓	✓	✓	4
Water mongoose	✓				✓								✓			✓		2
Total species	17	9	8	13	12	17	11	3	0	5	6	12	19	9	8	13	11	
Excluding domestic mammals and humans	14	9	7	11	9	15	10	3	0	5	6	10	15	6	4	10	8	

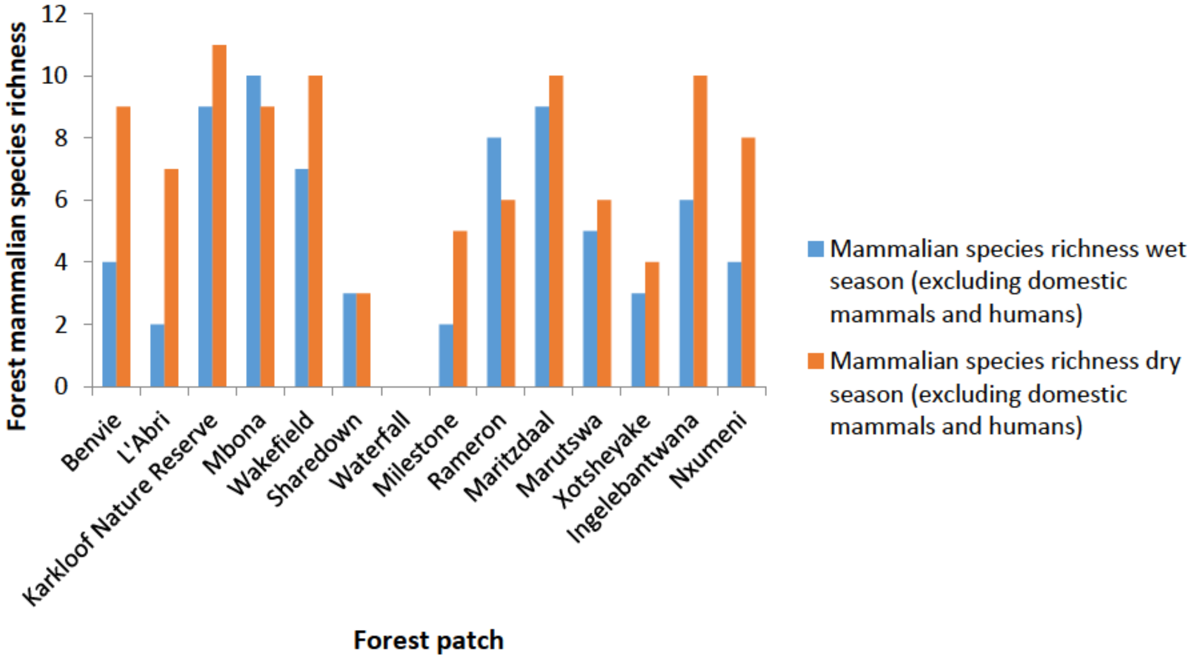

Figure 4.2 Forest mammalian species richness (excluding domestic mammals and humans) during the wet and dry season in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

Naïve occupancy varied greatly among the recorded species (Figure 4.4; Supplementary Information Table S4.2), with bushbuck having the highest naïve occupancy in the wet season (0.85) as well as the dry season (0.78), followed by Cape porcupine (wet season = 0.24; dry season = 0.46). In the wet season, tree hyrax, domestic goat, African climbing mice, and greater cane rat (*Thryonomys swinderianus*), had the lowest naïve occupancy (0.0061), with large grey mongoose *Herpestes ichneumon* and domestic goat having the lowest naïve occupancy in the dry season (0.0057) (Figure 4.4; Supplementary Information Table S4.2). Species present in the wet season, which were not recorded in the dry season, were greater cane rats. However, large grey mongoose, Cape clawless otter *Aonyx capensis* and serval *Leptailurus serval* were not recorded in the wet season despite being recorded in the dry season.

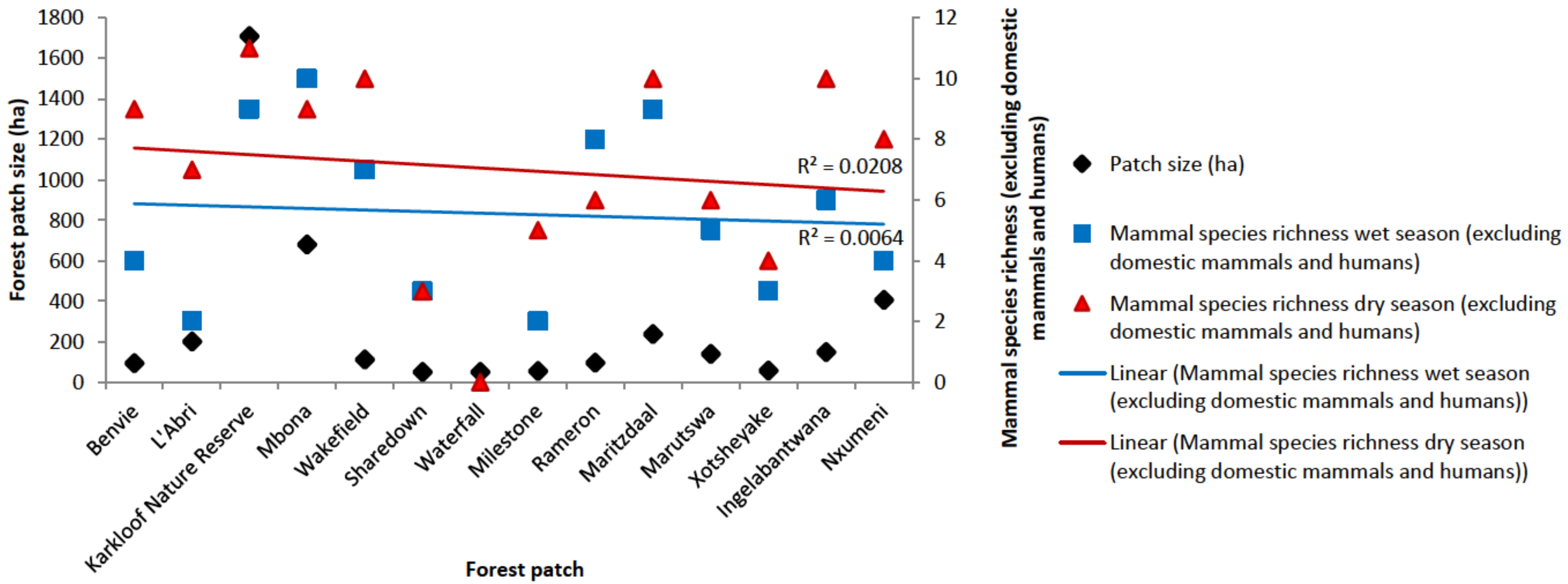

Figure 4.3 Linear regression analysis on the association between forest patch size and forest mammalian species richness (excluding domestic mammals and humans) during the wet and dry seasons in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

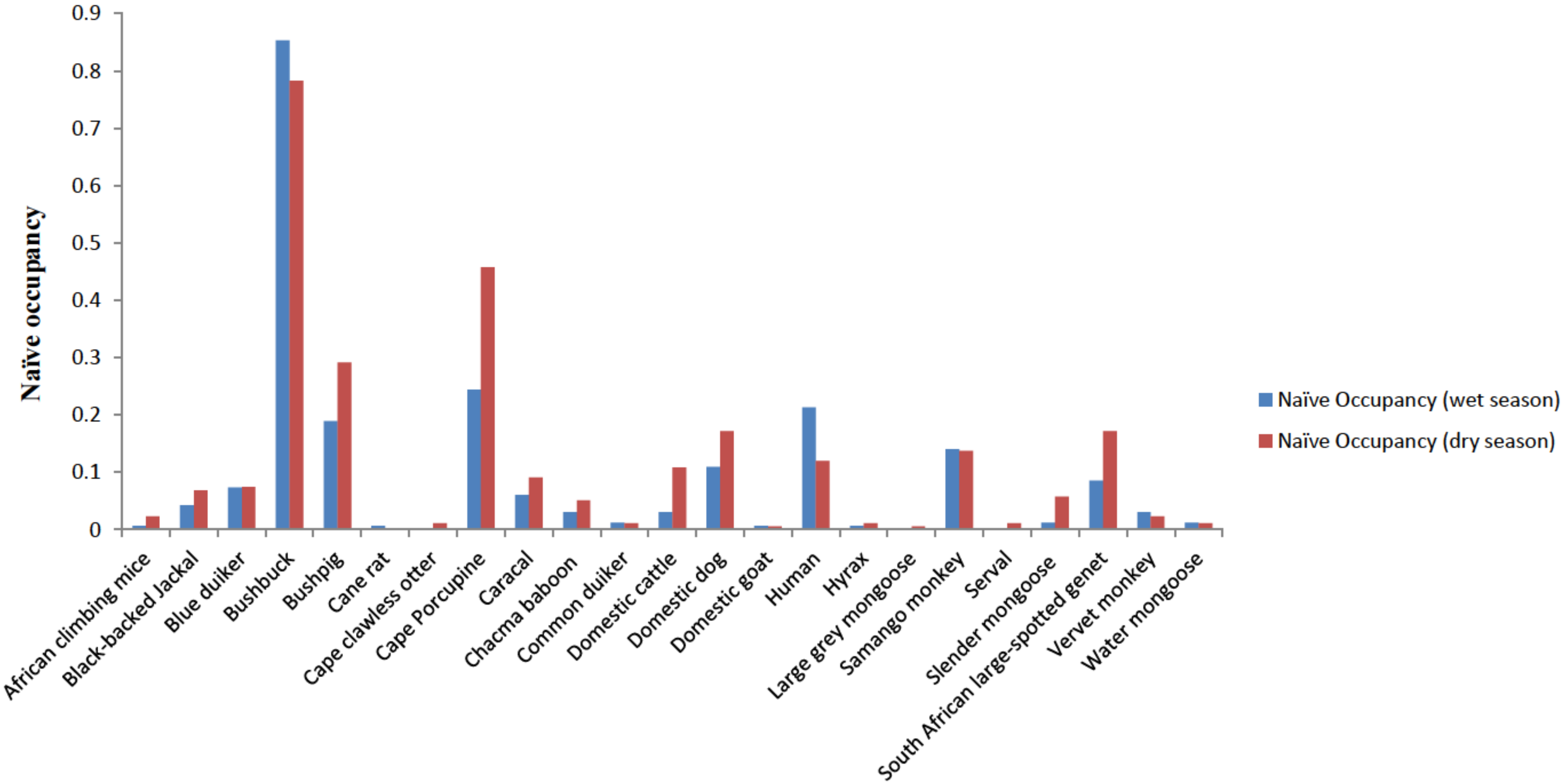

Figure 4.4 Naïve occupancy of mammalian species detected on the camera traps during the wet and dry season in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

Forest patch isolation distance showed significant variation, with the forest patches less than 200 ha generally being at least 7000 m from a mainland patch, except for Benvie, which had the shortest isolation distance of 920 m (Table 4.5). Forest patches with the highest isolation distance included Milestone (10790 m), Marutswa (10300 m) and Xotsheyake (8900 m).

Table 4.5 Isolation distance, calculated as the straight line distance from a surveyed forest patch to a forest patch at least 200 ha in size, and landscape configuration, calculated as the number of forest patches within 800 m of the surveyed forest patch in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

	Forest patch	**Minimum distance to mainland (200 ha)**	**Number of surrounding patches (within 800 m)**
Karkloof	Benvie	920 m	16
	L'Abri	0 m	15
	Karkloof Nature Reserve	0 m	25
	Mbona	0 m	29
Dargle	Wakefield	7300 m	7
	Sharedown	8400 m	5
	Waterfall	7440 m	4
	Milestone	10790 m	11
	Rameron	8500 m	9
	Maritzdaal	0 m	6
Bulwer	Marutswa	10300 m	4
	Xotsheyake	8900 m	8
	Ingelebantwana	8640 m	10
	Nxumeni	0 m	7

When assessing the relationship between forest patch isolation and forest mammalian species richness (Figure 4.5), it was apparent that the mainland patches (0 m isolation distance) had the highest species richness. However, there was no significant correlation between isolation distance and species richness outside these mainland patches, with species richness fluctuating across several isolation distances.

Overall landscape configuration showed that Karkloof had the highest average number of forest patches, within 800 m, surrounding each surveyed patch (21.25), followed by Bulwer (7.25) and Dargle (7). Mbona had the highest number of surrounding forest patches within 800 m (29; Table 4.5; Figure 4.6), followed by the Karkloof Nature Reserve (25) and Benvie (16). The lowest number of surrounding forest patches were experienced at Waterfall and Marutswa (4), followed by Sharedown (5). Forest mammalian species richness was generally higher in those forest patches surrounded by higher numbers of patches, with those forests surrounded by the fewest patches having a lower forest mammalian species richness. Forest patches with the highest number of surrounding patches in Karkloof also had the highest forest mammalian species richness, with species richness also being more consistent between seasons in these forest patches. A similar trend occurred in Dargle and Bulwer, whereby the forest patches with high numbers of surrounding patches (Wakefield, Rameron, Ingelebantwana) exhibited high forest mammalian species diversities compared with those forest patches surrounded by fewer patches (Sharedown, Waterfall, Marutswa). However, this trend was not observed in Xotsheyake, which had low species richness in the wet and dry seasons despite having numerous surrounding forest patches (n = 8).

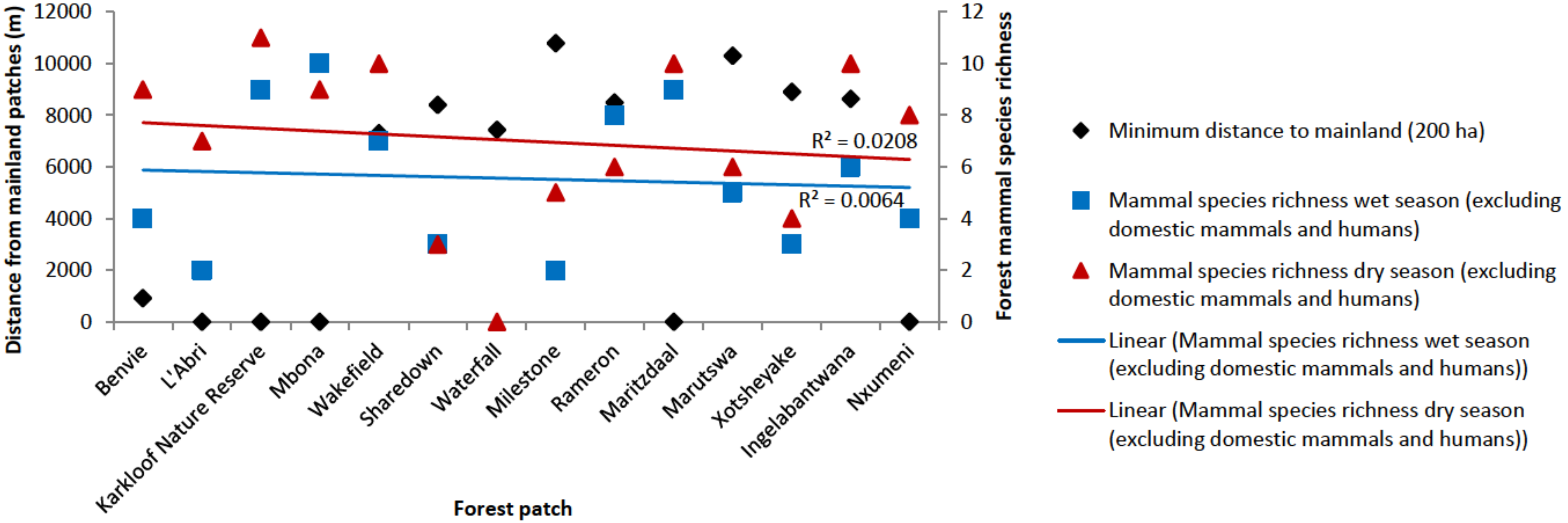

Figure 4.5 Linear regression analysis on the association between forest patch isolation distances from a mainland patch (200 ha) and forest mammalian species richness (excluding domestic mammals and humans) during the wet and dry seasons in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

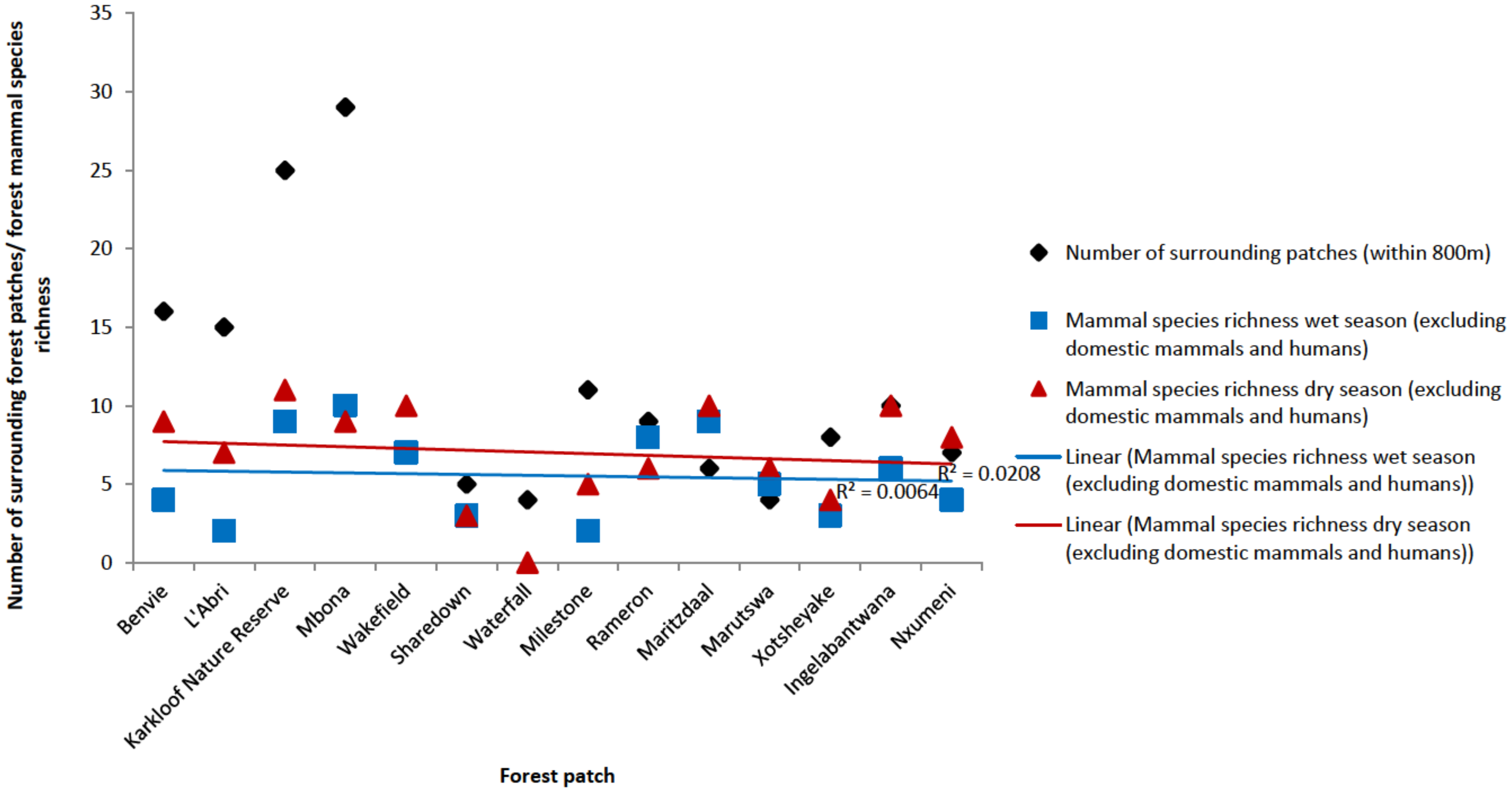

Figure 4.6 Linear regression analysis on the association between the number of forest patches, within 800 m, surrounding each surveyed forest and forest mammalian species richness (excluding domestic mammals and humans) in the wet and dry seasons in the Southern Mistbelt Forests in the midlands of KwaZulu-Natal, South Africa.

4.5 Discussion

The results collected in this study found that certain assumptions from MacArthur and Wilson's (1967) IBT were not always applicable in this study area, with island studies often differing from continental studies, resulting in limited applicability (Fox and Fox 2000). However, some aspects pertaining to a positive relationship between species richness and patch size, as well as landscape configuration, held mostly true in this study. As a result, only some of our initial predictions were supported in this study.

The prediction that larger forest patch sizes would harbour more species richness was generally true in this study, with the largest forest patches (Karkloof Nature Reserve, Mbona, Nxumeni and Maritzdaal) generally having a higher forest mammalian species diversity than the smaller forest patches. This may be the result of several factors, which include the fact that larger forest patches have more habitat (Hobbs 1988; Fahrig et al. 2019; Ferreira et al. 2020), with the smaller patches having a reduced habitat complexity, and thereby a homogenised habitat, limiting the resources and niches available for use (Ehlers Smith et al. 2018). The lack of sufficient resources in smaller patches was also identified in other studies (Santos-Filho et al. 2012), which found that small mammal diversities were unable to persist in high diversities in resource-limited forest patches, with the larger forest patches providing sufficient resources to support several small mammalian species. Forest patch size is generally seen as being a particularly important factor impacting species diversities in fragmented landscapes when compared with forest patch isolation or surrounding habitat (Palmeirim et al. 2020).

This is particularly true for forest specialist species, as the larger forest interior provides suitable conditions for these species to thrive, with high-quality patch interiors not being as essential for those forest generalist species (Takkis et al. 2018). This was also observed in this study, whereby the most specialised forest mammal, the blue duiker, was found in all three study sites; however, the number of detections varied considerably between forest patches and study sites. The majority (92.6%) of the detections of blue duiker were found in Karkloof (Supplementary Information Table S4.3), with the vast majority of these detections being within the Karkloof Nature Reserve, the largest sampled forest patch (1710 ha). However, across both seasons, there were only 68 detections of blue duikers across all study sites, yielding an average naïve occupancy of 0.07 across both seasons (Supplementary Information Table S4.2). This could indicate the lack of appropriate microhabitat conditions for these mammals in the majority of the surveyed forest patches, with blue duiker preferring a high fruit diet, which can be as high as 78.4 % of their total diet, with the species preferring dense, closed-canopy habitats, preferring thicker vegetation areas, which provides better protection from predation (Kendrick et al. 2009; Ehlers Smith et al. 2017b).

The general assumption that larger forest patches contain higher species diversities, thereby lowering the risk of local extinction (Yang et al. 2021), has resulted in most conservation measures having their efforts focused on conserving these patches, as smaller forest patches are deemed to be of lower conservation value (Ehlers Smith et al. 2018; Fahrig et al. 2019). However, this conservation approach is problematic for several reasons, which include the fact that, together, these small forest patches across a landscape could have a large total area, which could slowly diminish seemingly unnoticed, resulting in the local extinction of some species (Fahrig et al. 2019; Turner 1996). This is concerning as some studies (e.g., Ehlers Smith et al. 2018) have found that species richness could still be high even in these small forest patches, thereby constituting an important role in maintaining species richness across the landscape.

Landscape configuration (number of forest patches within 800 m of the sampled forest patch) also showed an overall positive relationship with species richness, with those forests surrounded by more forest patches generally having a higher species richness than those with few surrounding patches. These results coincide with those from a study conducted by Ehlers

Smith et al. (2018), which found that higher numbers of surrounding forest patches led to increased mammalian species diversity. This emphasises the role these surrounding patches play in ensuring connectivity between patches (Takkis et al. 2018), with these patches acting as ‘stepping stones’ in the mosaic landscape, and should therefore be considered vital for conservation (Ehlers Smith et al. 2018). This is particularly true in fragmented environments, whereby the inability of forest species to immigrate between forest patches could also affect the ability of plant species to colonise in these forests because of the lack of seed dispersers (Turner 1996).

Although not explicitly covered in this study, a factor also impacting the ability of forest mammals immigrating between forest patches relates to the overall nature and quality of the surrounding matrix, whereby hostile matrixes surrounding forest patches would create a barrier to movement, greatly impacting the ability of these mammalian species ability to move between patches (Santos-Filho et al. 2012). This could explain the reason why patches such as Marutswa, and in particular Xotsheyake, had low overall species richness despite having numerous forest patches surrounding them, as they were likely impacted by the surrounding local communities of people, which are known to impact mammal presence, particularly the larger mammals negatively (Ferreira et al. 2020). During data collection and on the camera traps, numerous hunting dogs and domestic cattle could be seen within the forests, with several snares being found in these forests as well (pers. obs.). The grazing and trampling by livestock could degrade the quality and reduce the diversity of the forest vegetation, thereby reducing the suitability of these forests to mammals (Ferreira et al. 2020; Sosibo et al. 2022).

However, forests surrounded by secondary forests and planted trees may significantly improve the ability of mammals to connect between forest patches (Turner 1996). Due to the importance of the surrounding matrix in determining the permeability of forest species between patches, IBT would not be highly applicable for continental patches, as these patches do not possess the same impenetrable barrier experienced by oceanic islands (Bueno and Peres 2019).

Although forest mammalian species richness showed a positive relationship with patch size and landscape configuration, isolation distance did not indicate a particularly positive influence. This could be because of the forests not being separate from species sources (Hobbs 1988), unlike oceanic islands (MacArthur and Wilson 1967). This is particularly true for generalist species, which are known to be less impacted by the effects of patch isolation (Takkis et al. 2018). As a result, species in the surrounding matrix have access to these forest patches, which, in turn, would negate the potential species losses resulting from forest isolation, making the IBT ineffective at describing the factors influencing species richness, at least for continental forest patches (Hobbs 1988). Similar to landscape configuration, the quality of the surrounding matrix and connectivity of patches (Takkis et al. 2018) would also have an impact on the effectiveness of patch isolation in determining species richness, as this could determine the ability of species to traverse across the matrix (Turner 1996; Santos-Filho et al. 2012; Takkis et al. 2018). This is particularly true for some species, which could still persist in isolated forest fragments based on the quality of the surrounding matrix and its overall permeability (Santos-Filho et al. 2012).

Mammalian species abundance did not show considerable variation between sampling seasons. However, the dry season produced few instances of three new species (Large grey mongoose, Cape clawless otter and serval), whilst the only species present in the wet season, which was not present in the dry season, was a single image capture of a greater cane rat. Although species richness between seasons was relatively similar, species richness per site between the wet and dry seasons exhibited considerable variations. The dry season displayed higher species richness per site than the wet season. This could primarily be because of the availability of food resources (Ngcobo et al. 2019), whereby species, such as Cape porcupines, would use forest resources during the dry season, using previously unwanted resources (Kraai et al. 2023), with forests also providing fruit resources when food availability is scarce (Salvador et al. 2011). This likely resulted in the noticeable increase in naïve occupancies during the dry season for the generalist species: Cape porcupine, bushpig and South African large-spotted genet *Genetta tigrina*. The use of forests during the dry season by generalist species could also be because of the use of these forests as refugia from fire, providing a suitable environment to ensure the survival of fire-sensitive species (Dornbusch et al. 2022), with these species being able to escape these fire affected areas (Bond and Parr 2010).

Forest specialist species, such as bushbuck and blue duiker, however, displayed relatively similar naïve occupancies between seasons, indicating the reliance on forest specialists on forests for food and shelter (Coates and Downs 2006). These findings were similar to those recorded in a study conducted by Sosibo et al. (2022), which found that the dry season has significantly higher abundances of medium-large-sized mammals in the sampled forests. The ability of these mammalian species to occupy the same forest patch would indicate sufficient diversity in food sources and resource availability to support these species, with more diverse habitats being able to support a greater diversity of species (Hannibal et al. 2019).

When compared with other forest mammal studies, such as a study conducted by Ehlers Smith et al. (2017b) in the Coastal Belt forests, it is clear that mammalian diversity in this study, as well as from a study conducted in Afromontane forests by Sosibo et al. (2022), are considerably less than the mammalian diversity observed in the coastal forests. These differences in mammalian species composition are suggested to be the result of palaeoclimatic extinction filtering, with Afromontane forests having fewer species and fewer forest-dependent species than coastal forests, with generalist species infiltrating these forest environments (Lawes et al. 2007). However, species richness might not always be higher in these coastal forests, with a study conducted by Zungu et al. (2019) recording two fewer mammalian species in urban coastal forests than the present study. However, their study recorded considerably more instances of forest specialist mammalian species, such as blue duiker, indicating the vulnerability of the forest-dependent mammals in the Afromontane forests to the infiltration of generalist mammalian species (Lawes et al. 2007) as found in the present study.

These specialist mammalian species may also be absent from many of the surveyed forest patches because of the hunting pressure exerted on these small isolated populations, with blue duiker being particularly at risk of local extinctions, which is especially true for the Afromontane forests in South Africa (Grande-Vega et al. 2016). As mentioned, these hunting pressures were observed in many of the forest patches surveyed in this study, particularly in the forests in Bulwer in the present study. Continued hunting pressures in these forests would certainly result in drastic population declines for several mammalian species, especially blue duiker (Grande-Vega et al. 2016).

Based on the forest characteristics focused on in this study, future conservation measures will hopefully shift away from the general notion that only the larger forest patches hold significant conservation value (Fahrig et al. 2019), with the smaller forest fragments being essential for the survival of many species across the landscape (Turner and Corlett 1996). Through the understanding of how uncontrolled hunting activities in protected forests impact the forest mammal species diversities, conservation managers should thus aim to prevent unsustainable hunting activities, which impacted mammalian species diversities in several forests, particularly those in Bulwer, which experienced the most observed (pers. obs. and recorded by camera traps) hunting activities.

4.6 Conclusions

When assessing the factors influencing forest mammalian species richness in the Southern Mistbelt Forests in the Midlands of KwaZulu-Natal, South Africa, it became apparent that not all aspects of MacArthur and Wilson's (1967) island biogeography theory applied to these forests. However, forest patch size and landscape configuration did display a positive relationship with forest mammalian species richness in these forests, particularly patch size. The positive relationship with patch size was determined to be likely because of the diverse habitat characterising these patches, which provide more suitable conditions for the forest specialist species, such as bushbuck and blue duiker. Landscape configuration likely had a generally positive correlation as these forest patches could act as 'stepping stones' for mammals to move between patches. However, the ability of forest mammalian species to use these surrounding patches could depend on the nature and quality of the surrounding matrix, which could act as a barrier to potential movement. Our results found that contrary to the IBT, isolation distance did not significantly impact species diversities, as species from the surrounding habitat could still use these forests, thereby negating the potential loss of species as a result of isolation. Like landscape configuration, the nature of the surrounding matrix would also have an impact on isolation distance, as forest mammals could potentially still connect to surrounding patches based on the permeability of this matrix. This reinforces the importance of conservation measures focused on smaller forest patches, which still hold tremendous conservation value for the landscape, contrary to the belief that only conserving larger patches would be sufficient. Camera trap records also found that, contrary to our initial prediction, the dry season had higher species richness per site than the wet season, with naïve occupancies of several generalist mammalian species, such as Cape porcupine, bushpig and South African large-spotted genet, being considerably higher in the dry season. This was likely the result of these forests being used for their food resources when food was scarce, with Cape porcupines, in particular, exploiting food resources that were generally avoided in the wet season, when food was more plentiful. Based on the nature of the grasslands surrounding these forests, the generalist species also likely used these forests as fire refugia, allowing these mammals to escape. However, forest specialist species, such as bushbuck and blue duiker, indicated relatively little naïve occupancy change between seasons, indicating their strong reliance on forests for food and shelter.

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4.8 References

Aben, J., Bocedi, G., Palmer, S.C., Pellikka, P., Strubbe, D., Hallmann, C., Travis, J.M., Lens, L. & Matthysen, E. (2016) The importance of realistic dispersal models in conservation planning: Application of a novel modelling platform to evaluate management scenarios in an Afrotropical biodiversity hotspot. *Journal of Applied Ecology*, **53**, 1055–1065.

Aben, J., Strubbe, D., Adriaensen, F., Palmer, S.C., Travis, J.M., Lens, L. & Matthysen, E. (2014) Simple individual-based models effectively represent Afrotropical forest bird movement in complex landscapes. *Journal of Applied Ecology*, **51**, 693-702.

Adie, H., Rushworth, I. & Lawes, M.J. (2013) Pervasive, long-lasting impact of historical logging on composition, diversity and above ground carbon stocks in Afrotemperate Forest. *Forest Ecology and Management*, **310**, 887–895.

Alexander, J., Ehlers Smith, D.A., Ehlers Smith, Y.C. & Downs, C.T. (2019) Eco-estates: Diversity Hotspots or isolated developments? Connectivity of eco-estates in the Indian Ocean Coastal Belt, KwaZulu-Natal, South Africa. *Ecological Indicators*, **103**, 425–433.

Amar, A. & Cloete, D. (2018) Quantifying the decline of the Martial Eagle *polemaetus bellicosus* in South Africa. *Bird Conservation International*, **28**, 363–374.

Anile, S. & Devillard, S. (2016) Study design and body mass influence RAIs from camera trap studies: Evidence from the Felidae. *Animal Conservation*, **19**, 35–45.

Arroyo-Rodríguez, V., Fahrig, L., Tabarelli, M., Watling, J.I., Tischendorf, L., Benchimol, M., Cazetta, E., Faria, D., Leal, I.R., Melo, F.P.L., Morante-Filho, J.C., Santos, B.A., Arasa-

Gisbert, R., Arce-Pena, N., Cervantes-Lopez, M.J., Cudney-Valenzuela, S., Galán-Acedo, C., San-José, M., Vieira, I.C.G., Silk, J.W.F., Nowakowski, A.J. & Tscharntke, T. (2020) Designing optimal human-modified landscapes for forest biodiversity conservation. *Ecology Letters*, **23**, 1404-1420.

Balestrieri, A., Cardarelli, E., Pandini, M., Remonti, L., Saino, N. & Prigioni, C. (2016) Spatial organisation of European badger (*Meles meles*) in northern Italy as assessed by camera-trapping. *European Journal of Wildlife Research*, **62**, 219–226.

Banks-Leite, C., Ewers, R.M., Folkard-Tapp, H. & Fraser, A. (2020) Countering the effects of habitat loss, fragmentation, and degradation through habitat restoration. *One Earth*, **3**, 672-676.

Beca, G., Valentine, L.E., Galetti, M. & Hobbs, R.J. (2022) Ecosystem roles and conservation status of bioturbator mammals. *Mammal Review*, **52**, 192-207.

Bell, K.E. & Donnelly, M.A. (2006) Influence of forest fragmentation on community structure of frogs and lizards in northeastern Costa Rica. *Conservation Biology*, **20**, 1750–1760.

Bond, W.J. & Parr, C.L. (2010) Beyond the forest edge: ecology, diversity and conservation of the grassy biomes. *Biological Conservation*, **143**, 2395-2404.

Brassine, E. & Parker, D. (2015) Trapping elusive cats: using intensive camera trapping to estimate the density of a rare African felid. *PLoS ONE*, **10**, e0142508.

Bueno, A.S. & Peres, C.A. (2019) Patch-scale biodiversity retention in fragmented landscapes: Reconciling the habitat amount hypothesis with the island biogeography theory. *Journal of Biogeography*, **46**, 621-632.

Chapman, P.M., Wearn, O.R., Riutta, T., Carbone, C., Rowcliffe, J.M., Bernard, H. & Ewers, R.M. (2018) Inter-annual dynamics and persistence of small mammal communities in a selectively logged tropical forest in Borneo. *Biodiversity and Conservation*, **27**, 3155–3169.

Chauvenet, A.L., Gill, R.M., Smith, G.C., Ward, A.I. & Massei, G. (2017) Quantifying the bias in density estimated from distance sampling and camera trapping of unmarked individuals. *Ecological Modelling*, **350**, 79-86.

Coates, G.D. & Downs, C.T. (2006) A preliminary study of valley thicket and coastal bushveld-grassland habitat use during summer by bushbuck (*Tragelaphus scriptus*): a telemetry based study. *South African Journal of Wildlife Research*, **36**, 167-172.

Cooper, T.J., Wannenburgh, A.M. & Cherry, M.I. (2017) Atlas data indicate forest dependent bird species declines in South Africa. *Bird Conservation International*, **27**, 337–354.

Cusack, J.J., Dickman, A.J., Kalyahe, M., Rowcliffe, J.M., Carbone, C., MacDonald, D.W. & Coulson, T. (2017) Revealing kleptoparasitic and predatory tendencies in an African mammal community using camera traps: A comparison of spatiotemporal approaches. *Oikos*, **126**, 812–822.

Diniz, M.F., Machado, R.B., Bispo, A.A. & Brito, D. (2018) Identifying key sites for connecting Jaguar populations in the Brazilian Atlantic Forest. *Animal Conservation*, **21**, 201–210.

Dornbusch, M.J., Limb, R.F., Bloom-Cornelius, I.V., Elmore, R.D., Weir, J.R. & Fuhlendorf, S.D. (2022) Factors influencing the persistence of a fire-sensitive *Artemisia* species in a fire-dependent ecosystem. *Ecological Applications*, **32**, e2604.

Dorning, J. & Harris, S. (2019) The challenges of recognising individuals with few distinguishing features: Identifying red foxes *Vulpes vulpes* from camera-trap photos. *PLoS ONE*, **14**, e0216531.

Ehlers Smith, D.A, Ehlers Smith, Y.C. & Downs, C.T. (2017a) Seasonal habitat requirements of Lemon Dove (*Aplopelia larvata*) in Coastal Forest: Camera-trap surveys of a reclusive species. *African Zoology*, **52**, 199-207.

Ehlers Smith, Y.C., Ehlers Smith, D.A., Ramesh, T. & Downs, C.T. (2018) Forest habitats in a mixed urban-agriculture mosaic landscape: patterns of mammal occupancy. *Landscape Ecology*, **33**, 59-76.

Ehlers Smith, Y.C., Ehlers Smith, D.A., Ramesh, T. & Downs, C.T. (2020) Landscape-scale drivers of mammalian species richness and functional diversity in forest patches within a mixed land-use mosaic. *Ecological Indicators*, **113**, 106176.

Ehlers Smith, Y.C, Ehlers Smith, D.A, Ramesh, T. & Downs, C.T. (2017b) The importance of microhabitat structure in maintaining forest mammal diversity in a mixed land-use mosaic. *Biodiversity and Conservation*, **26**, 2361-2382.

Fa, J.E. & Brown, D. (2009) Impacts of hunting on mammals in African tropical moist forests: a review and synthesis. *Mammal Review*, **39**, 231-264.

Fahrig, L. (2003) Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology, Evolution, and Systematics*, **34**, 487-515.

Fahrig, L. (2013) Rethinking patch size and isolation effects: the habitat amount hypothesis. *Journal of Biogeography*, **40**, 1649–1663.

Fahrig, L., Arroyo-Rodríguez, V., Bennett, J. R., Boucher-Lalonde, V., Cazetta, E., Currie, D. J., Eigenbrod, F., Ford, A.T., Harrison, S.P., Jaeger, J.A.G., Koper, N., Martin, A.E., Martin, J., Metzger, J.P., Morrison, P., Rhodes, J.R., Sainders, D.A., Simberloff, D., Smith, A.C., Tischendorf, L., Vellend, M. & Watling, J.I. (2019) Is habitat fragmentation bad for biodiversity? *Biological Conservation*, **230**, 179-186.

Ferreira, A.S., Peres, C.A., Dodonov, P. & Cassano, C.R. (2020) Multi-scale mammal responses to agroforestry landscapes in the Brazilian Atlantic Forest: the conservation value of forest and traditional shade plantations. *Agroforestry Systems*, **94**, 2331-2341.

Fox, B.J. & Fox, M.D. (2000) Factors determining mammal species richness on habitat islands and isolates: habitat diversity, disturbance, species interactions and guild assembly rules. *Global Ecology and Biogeography*, **9**, 19-37.

Giman, B., Stuebing, R., Megum, N., Mcshea, W.J. & Stewart, C.M. (2007) A camera trapping inventory for mammals in a mixed use planted forest in Sarawak. *Raffles Bulletin of Zoology*, **55**, 209-215.

Grande-Vega, M., Farfán, M.Á., Ondo, A. & Fa, J.E. (2016) Decline in hunter offtake of blue duikers in Bioko Island, Equatorial Guinea. *African Journal of Ecology*, **54**, 49-58.

Grass, I., Loos, J., Baensch, S., Batáry, P., Librán-Embid, F., Ficiciyan, A., Klaus, F., Riechers, M., Rosa, J., Tiede, J., Udy, K., Westphal, C., Wurz, A. & Tscharntke, T. (2019) Land-sharing/-sparing connectivity landscapes for ecosystem services and biodiversity conservation. *People and Nature*, **1**, 262-272.

Griffiths, M.E. & Lawes, M.J. (2006) Biogeographic, environmental, and phylogenetic influences on reproductive traits in subtropical forest trees, South Africa. *Ecography*, **29**, 614–622.

Hannibal, W., Cunha, N.L., Figueiredo, V.V., Teresa, F.B. & Ferreira, V.L. (2019) Traits reveal how habitat-quality gradients structure small mammal communities in a fragmented tropical landscape. *Austral Ecology*, **45**, 79–88.

Hegerl, C., Burgess, N.D., Nielsen, M.R., Martin, E., Ciolli, M. & Rovero, F. (2017) Using camera trap data to assess the impact of bushmeat hunting on forest mammals in Tanzania. *Oryx*, **51**, 87-97.

Helmus, M.R., Mahler, D.L. & Losos, J.B. (2014) Island biogeography of the Anthropocene. *Nature,* **513**, 543-546.

Hobbs, E.R. (1988) Species richness of urban forest patches and implications for urban landscape diversity. *Landscape Ecology*, **1**, 141-152.

Iezzi, M.E., Cruz, P., Varela, D., De Angelo, C. & Di Bitetti, M.S. (2018) Tree monocultures in a biodiversity hotspot: Impact of pine plantations on mammal and bird assemblages in the Atlantic Forest. *Forest Ecology and Management*, **424**, 216–227.

Kadoya, T., Takeuchi, Y., Shinoda, Y. & Nansai, K. (2022) Shifting agriculture is the dominant driver of forest disturbance in threatened forest species' ranges. *Communications Earth & Environment*, **3**, 108.

Kelatwang, S. & Garzuglia, M. (2006) Changes in forest area in Africa 1990-2005. *International Forestry Review*, **8**, 21-30.

Kendrick, E.L., Shipley, L.A., Hagerman, A.E. & Kelley, L.M. (2009) Fruit and fibre: the nutritional value of figs for a small tropical ruminant, the blue duiker (*Cephalophus monticola*). *African Journal of Ecology*, **47**, 556-566.

Kraai, U.M., Kraai, M., Tsvuura, Z., Mkhize, N.R. & Tjelele, T.J. (2023) The impacts of Cape porcupines on woody plant mortality. *Austral Ecology*, **00**, 1-10.

Lawes, M.J. & Chapman, C.A. (2006) Does the herb *Acanthus pubescens* and/or elephants suppress tree regeneration in disturbed Afrotropical Forest? *Forest Ecology and Management*, **221**, 278–284.

Lawes, M.J., Eeley, H.A., Findlay, N.J. & Forbes, D. (2007) Resilient Forest Faunal Communities in South Africa: A legacy of palaeoclimatic change and extinction filtering? *Journal of Biogeography*, **34**, 1246–1264.

Lawes, M.J., Lamb, B.C.C. & Boudreau, S. (2005) Area- but no edge-effect on woody seedling abundance and species richness in old Afromontane forest fragments. *Journal of Vegetation Science*, **16**, 363.

Lawes, M.J., MacFarlane, D.M. & Eeley, H.A. (2004) Forest landscape pattern in the KwaZulu-Natal midlands, South Africa: 50 Years of change or stasis? *Austral Ecology*, **29**, 613–623.

Lawes, M.J., Mealin, P.E. & Piper, S.E. (2000) Patch occupancy and potential metapopulation dynamics of three forest mammals in fragmented Afromontane forest in South Africa. *Conservation Biology*, **14**, 1088–1098.

Liu, J., Coomes, D.A., Gibson, L., Hu, G., Liu, J., Luo, Y., Wu, C. & Yu, M. (2019) Forest fragmentation in China and its effect on biodiversity. *Biological Reviews*, **94**, 1636–1657.

MacArthur, R.H. & Wilson, E.O. (1967) *The Theory of Island Biogeography*. Princeton University Press, Princeton.

Magrach, A., Laurance, W.F., Larrinaga, A.R. & Santamaria, L. (2014) Meta-analysis of the effects of forest fragmentation on interspecific interactions. *Conservation Biology*, **28**, 1342-1348.

Mangwale, K., Shackleton, C.M. & Sigwela, A. (2017) Changes in forest cover and carbon stocks of the coastal scarp forests of the Wild Coast, South Africa. *Southern Forests: A Journal of Forest Science*, **79**, 305-315.

Mann, G.K., O'Riain, M.J. & Parker, D.M. (2015) The road less travelled: assessing variation in mammal detection probabilities with camera traps in a semi-arid biodiversity hotspot. *Biodiversity and Conservation*, **24**, 531-545.

McAlpine, C.A., Rhodes, J.R., Callaghan, J.G., Bowen, M.E., Lunney, D., Mitchell, D.L., Pullar, D.V. & Possingham, H.P. (2006) The importance of forest area and configuration relative to local habitat factors for conserving forest mammals: a case study of koalas in Queensland, Australia. *Biological Conservation*, **132**, 153–165.

Mucina, L., Geldenhuys, C.J. & Rutherford, M.C. (2006) Afrotemperate, subtropical and azonal forests. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia*, **19**, 584-614.

Mucina, L. & Rutherford, M.C. (2006). *The Vegetation of South Africa, Lesotho and Swaziland*. South African National Biodiversity Institute, Pretoria.

Murcia, C. (1996). Forest Fragmentation and the Pollination of Neotropical Plants. In: Schelhas, J. & Greenberg, R (Eds.), *Forest Patches in Tropical Landscapes*. Island Press, Washington, D.C.

Ngcobo, S.P., Wilson, A.L. & Downs, C.T. (2019) Habitat selection of Cape porcupines in a farmland-suburban context in KwaZulu-Natal, South Africa. *Mammalian Biology*, **98**, 111-118.

Oberosler, V., Tenan, S., Zipkin, E.F. & Rovero, F. (2020) Poor management in protected areas is associated with lowered tropical mammal diversity. *Animal Conservation*, **23**, 171-181.

Palmeirim, A.F., Santos-Filho, M. & Peres, C.A. (2020) Marked decline in forest-dependent small mammals following habitat loss and fragmentation in an Amazonian deforestation frontier. *PLoS ONE*, **15**, e0230209.

Ramesh, T. & Downs, C.T. (2013) Impact of farmland use on population density and activity patterns of serval in South Africa. *Journal of Mammalogy*, **94**, 1460–1470.

Richard, U., Byamungu, R.M., Magige, F. & Makonda, F.B. (2022) Microhabitat, altitude and seasonal influence on the abundance of non-volant small mammals in Mount Rungwe forest nature reserve. *Global Ecology and Conservation*, **35**, e02069.

Ricketts, K. & Shackleton, C.M. (2020) Integrating livelihoods and forest conservation through beekeeping in northern KwaZulu-Natal. *Development Southern Africa*, **37**, 661-677.

Ridout, M.S. & Linkie, M. (2009) Estimating overlap of daily activity patterns from camera trap data. *Journal of Agricultural, Biological, and Environmental Statistics*, **14**, 322–337.

Ripple, W.J., Abernethy, K., Betts, M.G., Chapron, G., Dirzo, R., Galetti, M., Levi, T., Lindsey, P.A., Macdonald, D.W., Machovina, B., Newsome, T.M., Peres, C.A., Wallach, A.D., Wolf, C. & Young, H. (2016) Bushmeat hunting and extinction risk to the world's mammals. *Royal Society Open Science*, **3**, 160498.

Salvador, S., Clavero, M. & Pitman, R.L. (2011) Large mammal species richness and habitat use in an upper Amazonian forest used for ecotourism. *Mammalian Biology*, **76**, 115-123.

Santos-Filho, M., Peres, C.A., Da Silva, D.J. & Sanaiotti, T.M. (2012) Habitat patch and matrix effects on small-mammal persistence in Amazonian forest fragments. *Biodiversity and Conservation*, **21**, 1127-1147.

Sinclair, A.R.E. (2003) The role of mammals as ecosystem landscapers. *Alces: A Journal Devoted to the Biology and Management of Moose*, **39**, 161-176.

Sosibo, M.T., Ehlers Smith, D.A., Ehlers Smith, Y.C., Gumede, S.T., Ngcobo, S.P. & Downs, C.T. (2022) Mammalian assemblages in Southern Mistbelt Forests of the northern Eastern Cape, and southern KwaZulu-Natal Provinces, South Africa, and their response to bordering land-use. *Mammalian Biology*, **102**, 429-440.

Stoner, K.E. & Timm, R.M. (2011) Seasonally Dry Tropical Forest Mammals: Adaptations and Seasonal Patterns. In: Dirzo, R., Young, H.S., Mooney, H.A. and Ceballos, G (Eds.), *Seasonally Dry Tropical Forests*. Island Press, London.

Swinnen, K.R., Reijniers, J., Breno, M. & Leirs, H., 2014. A novel method to reduce time investment when processing videos from camera trap studies. *PLoS ONE*, **9**, e98881.

Symes, C.T., Wirminghaus, O.J., Downs, C.T. (2002) Species richness and seasonality of forest avifauna in three South African afromontane forests. *Ostrich*, **73**, 106–113.

Takkis, K., Kull, T., Hallikma, T., Jaksi, P., Kaljund, K., Kauer, K., Kull, T., Kurina, O., Külvik, M., Lanno, K., Leht, M., Liira, J., Melts, I., Pehlak, H., Raet, J., Sammet, K., Sepp, K., Väli, Ü. & Laanisto, L. (2018) Drivers of species richness and community integrity of small forest patches in an agricultural landscape. *Journal of Vegetation Science*, **29**, 978–988.

Taylor, M.R. & Peacock, F. (2018) *State of South Africa's Bird Report 2018*. BirdLife South Africa, Johannesburg.

Treves, A., Mwima, P., Plumptre, A.J. & Isoke, S. (2010) Camera-trapping forest–woodland wildlife of western Uganda reveals how gregariousness biases estimates of relative abundance and distribution. *Biological Conservation*, **143**, 521-528.

Turner, I.M. (1996) Species loss in fragments of tropical rain forest: a review of the evidence. *Journal of Applied Ecology*, 200-209.

Wethered, R. & Lawes, M.J. (2003) Matrix effects on bird assemblages in fragmented Afromontane forests in South Africa. *Biological Conservation*, **114**, 327–340.

White, F. (1978) The Afromontane Region. In: Werger, M.J.A (Eds.),. *Biogeography and Ecology of Southern Africa*. Springer, The Hague.

Wirminghaus, J.O., Downs, C.T., Symes, C.T. & Perrin, M.R. (1999) Conservation of the Cape Parrot in southern Africa. *South African Journal of Wildlife Research*, **29**, 118-129.

Wirminghaus, J.O. & Perrin, M.R. (1993) Seasonal changes in density, demography and body composition of small mammals in a southern temperate forest. *Journal of Zoology*, **229**, 303-318.

Wu, J. & Vankat, J.L. (1995) Island biogeography: theory and applications. *Encyclopedia of Environmental Biology*, **2**, 371-379.

Xiao, H., Liu, J., He, G., Zhang, X., Wang, H., Long, T., Zhang, Z., Wang, W., Yin, R., Guo, Y., Cheng, B & Cao, Q. (2022) Data-driven forest cover change and its driving factors analysis in Africa. *Frontiers in Environmental Science*, **9**, 660.

Yang, J., Yang, J., Xing, D., Luo, X., Lu, S., Huang, C. & Hahs, A.K. (2021) Impacts of the remnant sizes, forest types, and landscape patterns of surrounding areas on woody plant diversity of urban remnant forest patches. *Urban Ecosystems*, **24**, 345-354.

Zungu, M.M., Maseko, M.S.T., Kalle, R., Ramesh, T. & Downs, C.T. (2019) Fragment and life-history correlates of extinction vulnerability of forest mammals in an urban-forest mosaic in EThekwini Municipality, Durban, South Africa. *Animal Conservation*, **22**, 362-375.

4.9 Supplementary information

Supplementary Information Table S4.1 Forest mammalian species identified using camera traps in the present study.

Forest mammalian species	**Latin name**
African climbing mice	*Dendromus* spp.
Black-backed Jackal	*Canis mesomelas*
Blue duiker	*Philantomba monticola*
Bushbuck	*Tragelaphus sylvaticus*
Bushpig	*Potamochoerus larvatus*
Cape clawless otter	*Aonyx capensis*
Cane rat	*Thryonomys swinderianus*
Cape porcupine	*Hystrix africaeaustralis*
Caracal	*Caracal caracal*
Chacma baboon	*Papio ursinus*
Common duiker	*Sylvicapra grimmia*
Large grey mongoose	*Herpestes ichneumon*
Hyrax	Hyracoidea
Samango monkey	*Cercopithecus albogularis*
Serval	*Leptailurus serval*
Slender mongoose	*Galerella sanguinea*
South African large-spotted genet	*Genetta tigrina*
Vervet monkey	*Cercopithecus pygerythrus*
Water mongoose	*Atilax paludinosus*

Supplementary Information Table S4.2 Naïve occupancy (wet and dry seasons respectively) of forest mammalian species identified using camera traps in the present study.

Mammalian species	Naïve occupancy (wet season)	Naïve occupancy (dry season)
African climbing mice	0.0061	0.0229
Black-backed Jackal	0.0427	0.0686
Blue duiker	0.0732	0.0743
Bushbuck	0.8537	0.7829
Bushpig	0.1890	0.2914
Cane rat	0.0061	0.0000
Cape clawless otter	0.0000	0.0114
Cape Porcupine	0.2439	0.4571
Caracal	0.0610	0.0914
Chacma baboon	0.0305	0.0514
Common duiker	0.0122	0.0114
Domestic cattle	0.0305	0.1086
Domestic dog	0.1098	0.1714
Domestic goat	0.0061	0.0057
Human	0.2134	0.1200
Hyrax	0.0061	0.0114
Large grey mongoose	0.0000	0.0057
Samango monkey	0.1402	0.1371
Serval	0.0000	0.0114
Slender mongoose	0.0122	0.0571
South African large-spotted genet	0.0854	0.1714
Vervet monkey	0.0305	0.0229
Water mongoose	0.0122	0.0114

Supplementary Information Table S4.3 Total number of blue duiker captured on camera traps across each forest cluster for the wet and dry seasons in the present study.

Forest cluster	Total captures of blue duiker	Percentage of total (%)
Karkloof	63	92.7
Dargle	1	1.5
Bulwer	4	5.9

CHAPTER 5

Conclusions and Recommendations

5.1 Overview

Forests around the world provide valuable ecosystem services, such as the maintenance of species diversity, aiding in the protection of soil and maintaining the hydrological cycle (Kelatwang and Garzuglia 2006; Mithal et al. 2011). Forest mammals, in particular, play a vital role in the plant-animal relationship, with these mammals often acting as seed dispersers, with the removal of these mammalian species results in the reduction in ecosystem stability (Oblerosler et al. 2020; Grande-Vega et al. 2016; Hegerl et al. 2017). One of the biggest threats to biodiversity includes habitat loss, fragmentation and global population growth (Aben et al. 2014; 2016; Alexander et al. 2019). For forested landscapes, fragmentation is particularly impactful, as it causes the breaking up of an otherwise continuous forest into several smaller patches (Liu et al. 2019), which results in reduced patch size, a reduction in connectivity between patches and an increase in edge effects (Fahrig 2003; Liu et al. 2019; Banks-Leite et al. 2020). As a result, many species' distributions and presence become affected, thereby causing an impact on overall ecological interactions (Magrach et al. 2014). The effects fragmentation has on species are not uniform, however, with specialist species being more affected because of their reliance on these ecological interactions (Magrach et al. 2014; Banks-Leite et al. 2020). Fragmentation, thus, almost certainly results in the local extinction of some species; however, the adoption of informed conservation strategies based on species abundance and density data (Anile and Devillard 2016; Agha et al. 2018) could allow some species to inhabit the fragmented forest landscapes (Murcia 1996; Grass et at. 2019; Arroyo-Rodríguez et al. 2020).

To effectively monitor wildlife abundance and densities, camera traps have become an increasingly popular tool since the 1990s (Anile and Devillard 2016; Agha et al. 2018; Zwerts et al. 2021), with their popularity being particularly prominent over the last two decades (Galvis et al. 2014). Camera traps allow researchers to study mammalian species, particularly elusive species, in a non-invasive, cost-effective way (Dupuis-Desormeaux et al. 2016; Ferreras et al. 2017; Dorning and Harris 2019). Their use is particularly effective in those dense environments, such as forests, which make directly observing wildlife challenging (Giman et al. 2007; Treves et al. 2010).

To describe the impacts of fragmentation on species diversity, MacArthur and Wilson's (1967) island biogeography theory (IBT) has been used, which compares fragmented forests to oceanic islands, with the IBT assuming there is a harsh matrix surrounding them (Bueno and Peres 2019), usually in the form of agricultural land, or an area experiencing converted land use (Fox and Fox 2000). The IBT postulates that species occurring in smaller forest fragments is the result of species moving from the mainland, which is seen as the source of species occurring in the landscape (Fahrig 2013). As a result, forest patches occurring at increasing isolation distances from this mainland patch would cause a decrease in species richness occupying those patches, with more closely related species likely occupying them (Wu and Vankat 1995; Fahrig 2013; Helmus et al. 2014). The larger forest patches are assumed to contain more species diversities as they exhibit higher speciation, with there being a greater diversity of habitat types (Fox and Fox 2000; Ehlers Smith et al. 2020), thereby reducing the risk of local extinction of species in these patches (Yang et al. 2021). Based on this, factors such as patch size, surrounding habitat matrix, and dispersal and mobility capabilities impact the species being found in fragmented forest patches (Ehlers Smith et al. 2020).

However, the IBT has received criticism as it does not account for species being able to traverse between habitat patches, which do not present the same barrier experienced by oceanic islands (Fahrig 2013; Bueno and Peres 2019). The ability of species being able to move between forest patches would likely be because of the overall nature and quality of the landscape mosaic (Santos-Filho et al. 2012).

To determine the effects of anthropogenic disturbance and forest fragmentation on forest mammalian species diversities, the naturally small and fragmented Afromontane forest patches in South Africa provide the ideal opportunity. Climatic changes experienced during and before the last glacial maximum (LGM) resulted in the vegetation changes experienced, with these forests exhibiting fairly constant size and distribution since (Lawes et al. 2000a; Lawes et al. 2005; Adie et al. 2013). However, anthropogenic activities, mainly in the form of intense logging between 1870 and 1944 by the colonial settlers, have worsened the natural fragmentation of these forests (Lawes et al. 2000b, 2004; Wethered and Lawes 2003; Adie et al. 2013). Although logging activities have since been banned, present anthropogenic pressures in the form of uncontrolled harvesting of fuelwood, increased fire frequency, collection of building materials and collection of medicinal plants have maintained the pressures exerted on these forests (Lawes et al. 2004; Cooper et al. 2017).

This study sought to determine the use of camera traps as a research tool in Africa, highlighting the countries and terrestrial wildlife receiving the most focus, with the study going further to determine the impacts microhabitat structure and landscape configuration had on the mammalian species diversity found in the historically fragmented forest patches, in the midlands of KwaZulu-Natal, South Africa, between the wet and dry seasons.

5.2 Research findings

The study in Chapter 2 aimed to determine the use of camera traps as a research tool in Africa, revealing the countries receiving the most camera trap research focus. The study further identified the terrestrial wildlife and habitat types receiving the most focus. Results from this study found that South Africa received the most camera trap research attention, with the majority of studies primarily focusing on identifying the occupancy of terrestrial mammals (Chapter 2). This mostly focused on large carnivores, with leopard *Panthera pardus* being the most studied species (Chapter 2). The study found that the majority of camera trap research was conducted in forests, likely because of the usefulness of camera traps in dense environments (Chapter 2).

Research in Chapter 3 focused on identifying the impact microhabitat has on bushbuck *Tragelaphus scriptus*, a diurnal forest specialist, and Cape porcupine *Hystrix africaeaustralis*, a nocturnal generalist, in the Southern Mistbelt forests in the Midlands of KwaZulu-Natal, South Africa, and how the microhabitat conditions potentially impacted their occupancy between the austral wet and dry seasons, with the change in seasons resulting in an altered microhabitat structure, thus impacting food availability. These changes in available food resources were thought to impact forest specialist and generalist species differently, with the generalist species being able to alter their diet based on the available resources, whereas the specialist species would need to either shift preferred habitats within the forest or migrate out the forest entirely in search of food resources. The study found that bushbuck was the most recorded mammalian species during both seasons, with the occupancy of Cape porcupine being higher during the dry season (Chapter 3). This was found to be likely because of the generalist feeding nature of the Cape porcupine, utilising the resources in forests during the dry season when food may have been otherwise scarce (Chapter 3). In state-owned forests, bushbuck presence was considerably lower, which was likely the result of the observed hunting activity presently taking place in these forests (Chapter 3).

The research conducted in Chapter 4 aimed to determine the impacts of landscape factors, which included patch size, landscape configuration (number of neighbouring patches), and patch isolation (distance from mainland patch), on forest mammalian species diversity in the Southern Mistbelt forest patches, between the wet and dry seasons. The findings indicated that forest mammalian diversity was strongly influenced by patch size, with larger forest patches generally having significantly higher mammalian diversity than the smaller patches (Chapter 4). Landscape configuration also displayed a positive correlation with mammalian species richness, with forests surrounded by multiple forest patches generally having an increased diversity (Chapter 4). Patch isolation, however, did not indicate a significant influence on forest mammalian species richness (Chapter 4).

5.3 Conclusions and recommendations

The findings from Chapter 2 indicated that camera trap research was conducted using multiple different procedures, often depending on the research question and resources available to the study (Meek et al. 2015; Roberts 2011), which makes establishing a standardised method challenging. However, this study illuminated the need for an appropriate sampling effort to be established in each study, particularly when the research focuses on rare species, with insufficient sampling efforts negatively impacting the ability of the research to answer the questions posed (Burton et al. 2015). Further camera trap installation procedure recommendations relate to a more standardised height and deployment times of camera traps, with variations in these procedures also impacting the results of studies and the inferences made (Burton et al. 2015; Ferreras et al. 2017; Rich et al. 2019).

When assessing the impacts that landscape configuration has on forest mammalian species diversity, it is apparent that, contrary to the IBT, the small forest patches play a vital role in ensuring forest mammals can traverse the landscape, with these patches acting as ‘stepping stones’ between forest patches, with results indicating that potential localised extinctions in these smaller forest patches have not yet taken place. Therefore, future conservation measures must not overlook the importance of conserving these forest fragments, with the loss of these patches having ecological consequences (Fahrig et al. 2019). The maintenance and enhancement of landscape connectivity, through the presence of smaller forest patches, further ensure that wildlife is unlikely to be overhunted, ensuring the presence of vulnerable large-bodied mammals (Ferreira et al. 2020). This study found that the IBT was generally not applicable to the sampled forest fragments, as the landscape mosaic surrounding the patches is likely also to determine the species richness across the landscape (Hobbs 1988). Due to the interconnected nature of the forests and their surrounding habitat, it is recommended to determine species richness across different habitat types of the landscape, as this could provide insights into the overall health of the landscape, with higher diversities allowing for the increase in resources available, thereby allowing the environment to support additional species (Hobbs 1988) further.

Although this study illuminated the positive relationship forest mammalian species richness had with increasing patch size, one factor we did not implement in this study, which could provide meaningful insights, relates to the investigation of patch shape in influencing species diversities in these fragmented forests. Forest patch shape could determine the effectiveness of possible species exchange between forests and the surrounding habitats, with complex patch shapes often positively influencing this exchange (Yang et al. 2021). Patch shape could also be an important factor to consider, as a patch could be large, but narrow, which would not favour the mesic and shade-tolerant species (Hobbs 1988).

This research also highlighted the likely effect uncontrolled resource harvesting had on both plant/tree richness and forest mammalian species richness, particularly between privately-owned and state-owned forests. These impacts were particularly noticeable in the state-owned forests in Bulwer, specifically Marutswa and Xotsheyake, whereby cattle grazing and resource collection, in the form of fuelwood and hunting, were observed both on the ground and on camera traps, which included the use of hunting dogs and snares, likely resulted in the low species detected here. To fully understand the impacts these activities have on forest environments, it is recommended that information is collected regarding the amount of resources being extracted and to determine the particular species targeted. Based on this data, resource collection should be conducted in a sustainable manner to ensure local extinctions of both plant/tree and forest mammalian species does not occur.

5.4 References

Aben, J., Bocedi, G., Palmer, S.C., Pellikka, P., Strubbe, D., Hallmann, C., Travis, J.M., Lens, L. & Matthysen, E. (2016) The importance of realistic dispersal models in conservation planning: Application of a novel modelling platform to evaluate management scenarios in an Afrotropical biodiversity hotspot. *Journal of Applied Ecology*, **53**, 1055–1065.

Aben, J., Strubbe, D., Adriaensen, F., Palmer, S.C., Travis, J.M., Lens, L. & Matthysen, E. (2014) Simple individual-based models effectively represent Afrotropical forest bird movement in complex landscapes. *Journal of Applied Ecology*, **51**, 693-702.

Adie, H., Rushworth, I. & Lawes, M.J. (2013) Pervasive, long-lasting impact of historical logging on composition, diversity and above ground carbon stocks in Afrotemperate Forest. *Forest Ecology and Management*, **310**, 887–895.

Agha, M., Batter, T., Bolas, E.C., Collins, A.C., Gomes da Rocha, D., Monteza-Moreno, C.M., Preckler-Quisquater, S. & Sollmann, R. (2018) A review of wildlife camera trapping trends across Africa. *African Journal of Ecology*, **56**, 694-701.

Alexander, J., Ehlers Smith, D.A., Ehlers Smith, Y.C. & Downs, C.T. (2019) Eco-estates: Diversity Hotspots or isolated developments? Connectivity of eco-estates in the Indian Ocean Coastal Belt, KwaZulu-Natal, South Africa. *Ecological Indicators*, **103**, 425–433.

Anile, S. & Devillard, S. (2016) Study design and body mass influence RAIs from camera trap studies: evidence from the Felidae. *Animal Conservation*, **19**, 35–45.

Arroyo-Rodríguez, V., Fahrig, L., Tabarelli, M., Watling, J.I., Tischendorf, L., Benchimol, M., Cazetta, E., Faria, D., Leal, I.R., Melo, F.P.L., Morante-Filho, J.C., Santos, B.A., Arasa-Gisbert, R., Arce-Pena, N., Cervantes-Lopez, M.J., Cudney-Valenzuela, S., Galán-Acedo, C., San-José, M., Vieira, I.C.G., Silk, J.W.F., Nowakowski, A.J. & Tscharntke, T. (2020) Designing optimal human-modified landscapes for forest biodiversity conservation. *Ecology Letters*, **23**, 1404-1420.

Banks-Leite, C., Ewers, R.M., Folkard-Tapp, H. & Fraser, A. (2020) Countering the effects of habitat loss, fragmentation, and degradation through habitat restoration. *One Earth*, **3**, 672-676.

Bueno, A.S. & Peres, C.A. (2019) Patch-scale biodiversity retention in fragmented landscapes: Reconciling the habitat amount hypothesis with the island biogeography theory. *Journal of Biogeography*, **46**, 621-632.

Burton, A.C., Neilson, E., Moreira, D., Ladle, A., Steenweg, R., Fisher, J.T., Bayne, E. & Boutin, S. (2015) Wildlife camera trapping: a review and recommendations for linking surveys to ecological processes. *Journal of Applied Ecology*, **52**, 675-685.

Cooper, T.J., Wannenburgh, A.M. & Cherry, M.I. (2017) Atlas data indicate forest dependent bird species declines in South Africa. *Bird Conservation International*, **27**, 337–354.

Dorning, J. & Harris, S. (2019) The challenges of recognising individuals with few distinguishing features: identifying red foxes *Vulpes vulpes* from camera-trap photos. *PLoS ONE*, **14**, e0216531.

Dupuis-Desormeaux, M., Davidson, Z., Mwololo, M., Kisio, E. & MacDonald, S.E. (2016) Comparing motion capture cameras versus human observer monitoring of mammal movement through fence gaps: a case study from Kenya. *African Journal of Ecology*, **54**, 154-161.

Ehlers Smith, Y.C., Ehlers Smith, D.A., Ramesh, T. & Downs, C.T. (2020) Landscape-scale drivers of mammalian species richness and functional diversity in forest patches within a mixed land-use mosaic. *Ecological Indicators*, **113**, 106176.

Fahrig, L. (2003) Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology, Evolution, and Systematics*, **34**, 487-515.

Fahrig, L. (2013) Rethinking patch size and isolation effects: the habitat amount hypothesis. *Journal of Biogeography*, **40**, 1649–1663.

Fahrig, L., Arroyo-Rodríguez, V., Bennett, J. R., Boucher-Lalonde, V., Cazetta, E., Currie, D. J., Eigenbrod, F., Ford, A.T., Harrison, S.P., Jaeger, J.A.G., Koper, N., Martin, A.E., Martin, J., Metzger, J.P., Morrison, P., Rhodes, J.R., Sainders, D.A., Simberloff, D., Smith, A.C., Tischendorf, L., Vellend, M. & Watling, J.I. (2019) Is habitat fragmentation bad for biodiversity? *Biological Conservation*, **230**, 179-186.

Ferreira, A.S., Peres, C.A., Dodonov, P. & Cassano, C.R. (2020) Multi-scale mammal responses to agroforestry landscapes in the Brazilian Atlantic Forest: the conservation value of forest and traditional shade plantations. *Agroforestry Systems*, **94**, 2331-2341.

Ferreras, P., Díaz-Ruiz, F., Alves, P.C. & Monterroso, P. (2017) Optimizing camera-trapping protocols for characterizing mesocarnivore communities in south-western Europe. *Journal of Zoology*, **301**, 23-31.

Fox, B.J. & Fox, M.D. (2000) Factors determining mammal species richness on habitat islands and isolates: habitat diversity, disturbance, species interactions and guild assembly rules. *Global Ecology and Biogeography*, **9**, 19-37.

Galvis, N., Link, A. & Di Fiore, A. (2014) A novel use of camera traps to study demography and life history in wild animals: a case study of spider monkeys (*Ateles belzebuth*). *International Journal of Primatology*, **35**, 908-918.

Giman, B., Stuebing, R., Megum, N., Mcshea, W.J. & Stewart, C.M. (2007) A camera trapping inventory for mammals in a mixed use planted forest in Sarawak. *Raffles Bulletin of Zoology*, **55**, 209-215.

Grande-Vega, M., Farfán, M.Á., Ondo, A. & Fa, J.E. (2016) Decline in hunter offtake of blue duikers in Bioko Island, Equatorial Guinea. *African Journal of Ecology*, **54**, 49-58.

Grass, I., Loos, J., Baensch, S., Batáry, P., Librán-Embid, F., Ficiciyan, A., Klaus, F., Riechers, M., Rosa, J., Tiede, J., Udy, K., Westphal, C., Wurz, A. & Tscharntke, T. (2019) Land-sharing/-sparing connectivity landscapes for ecosystem services and biodiversity conservation. *People and Nature*, **1**, 262-272.

Hegerl, C., Burgess, N.D., Nielsen, M.R., Martin, E., Ciolli, M. & Rovero, F. (2017) Using camera trap data to assess the impact of bushmeat hunting on forest mammals in Tanzania. *Oryx*, **51**, 87-97.

Helmus, M.R., Mahler, D.L. & Losos, J.B. (2014) Island biogeography of the Anthropocene. *Nature*, **513**, 543-546.

Hobbs, E.R. (1988) Species richness of urban forest patches and implications for urban landscape diversity. *Landscape Ecology*, **1**, 141-152.

Kelatwang, S. & Garzuglia, M. (2006) Changes in forest area in Africa 1990-2005. *International Forestry Review*, **8**, 21-30.

Lawes, M.J., Eeley, H.A. & Piper, S.E. (2000a) The relationship between local and regional diversity of indigenous forest fauna in KwaZulu-Natal Province, South Africa. *Biodiversity and Conservation*, **9**, 683-705.

Lawes, M.J., Lamb, B.C.C. & Boudreau, S. (2005) Area- but no edge-effect on woody seedling abundance and species richness in old Afromontane forest fragments. *Journal of Vegetation Science*, **16**, 363.

Lawes, M.J., MacFarlane, D.M. & Eeley, H.A. (2004) Forest landscape pattern in the KwaZulu-Natal midlands, South Africa: 50 years of change or stasis? *Austral Ecology*, **29**, 613–623.

Lawes, M.J., Mealin, P.E. & Piper, S.E. (2000b) Patch occupancy and potential metapopulation dynamics of three forest mammals in fragmented Afromontane forest in South Africa. *Conservation Biology*, **14**, 1088–1098.

Liu, J., Coomes, D.A., Gibson, L., Hu, G., Liu, J., Luo, Y., Wu, C. & Yu, M. (2019) Forest fragmentation in China and its effect on biodiversity. *Biological Reviews*, **94**, 1636–1657.

MacArthur, R.H. & Wilson, E.O. (1967) *The Theory of Island Biogeography*. Princeton University Press, Princeton.

Magrach, A., Laurance, W.F., Larrinaga, A.R. & Santamaria, L. (2014) Meta-analysis of the effects of forest fragmentation on interspecific interactions. *Conservation Biology*, **28**, 1342-1348.

Meek, P.D., Ballard, G.A. & Fleming, P.J. (2015) The pitfalls of wildlife camera trapping as a survey tool in Australia. *Australian Mammalogy*, **37**, 13-22.

Mithal, V., Garg, A., Boriah, S., Steinbach, M., Kumar, V., Potter, C., Klooster, S. & Castilla-Rubio, J.C. (2011) Monitoring global forest cover using data mining. *ACM Transactions on Intelligent Systems and Technology (TIST)*, **2**, 1-24.

Murcia, C. (1996). Forest Fragmentation and the Pollination of Neotropical Plants. In: Schelhas, J. & Greenberg, R (Eds.), *Forest Patches in Tropical Landscapes*. Island Press, Washington, D.C.

Oberosler, V., Tenan, S., Zipkin, E.F. & Rovero, F. (2020) Poor management in protected areas is associated with lowered tropical mammal diversity. *Animal Conservation*, **23**, 171-181.

Rich, L.N., Miller, D.A., Muñoz, D.J., Robinson, H.S., McNutt, J. W. & Kelly, M.J. (2019) Sampling design and analytical advances allow for simultaneous density estimation of seven sympatric carnivore species from camera trap data. *Biological Conservation*, **233**, 12-20.

Roberts, N.J. (2011) Investigation into survey techniques of large mammals: surveyor competence and camera-trapping vs. transect-sampling. *Bioscience Horizons*, **4**, 40-49.

Santos-Filho, M., Peres, C.A., Da Silva, D.J. & Sanaiotti, T.M. (2012) Habitat patch and matrix effects on small-mammal persistence in Amazonian forest fragments. *Biodiversity and Conservation*, **21**, 1127-1147.

Treves, A., Mwima, P., Plumptre, A.J. & Isoke, S. (2010) Camera-trapping forest–woodland wildlife of western Uganda reveals how gregariousness biases estimates of relative abundance and distribution. *Biological Conservation*, **143**, 521-528.

Wethered, R. & Lawes, M.J. (2003) Matrix effects on bird assemblages in fragmented Afromontane forests in South Africa. *Biological Conservation*, **114**, 327–340.

Wu, J. & Vankat, J.L. (1995) Island biogeography: theory and applications. *Encyclopedia of Environmental Biology*, **2**, 371-379.

Yang, J., Yang, J., Xing, D., Luo, X., Lu, S., Huang, C. & Hahs, A.K. (2021) Impacts of the remnant sizes, forest types, and landscape patterns of surrounding areas on woody plant diversity of urban remnant forest patches. *Urban Ecosystems*, **24**, 345-354.

Zwerts, J.A., Stephenson, P.J., Maisels, F., Rowcliffe, M., Astaras, C., Jansen, P.A., Waarde, J., Sterck, L.E., Verweij, P.A., Bruce, T., Brittain, S. & Kuijk, M. (2021) Methods for wildlife monitoring in tropical forests: comparing human observations, camera traps, and passive acoustic sensors. *Conservation Science and Practice*, **3**, e568.